

AN ATLAS OF ABSORPTION SPECTRA

BY

C. E. KENNETH MEES



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AN ATLAS OF ABSORPTION SPECTRA.

INTRODUCTION.

One of the branches of our Works being concerned with the manufacture of Colour Filters for all purposes, our laboratory has naturally devoted a considerable amount of attention to the measurement of dye-stuffs, with a view to selecting those suitable for various purposes. Of published records of Absorptions, there are few, and the only atlas of Absorption Spectra, giving Spectra in a convenient form, which is accessible to the student, is the very valuable atlas by Uhler & Wood, published by the Carnegie Institute of Washington. The book by Formánek, useful as it is, can scarcely be termed an "Atlas."

The above-mentioned Atlas was prepared specially with regard to absorptions in the ultra-violet, and to this end the spectra have been photographed with great care; but for the purpose of producing filters for visual work and for photographic work with red-sensitive plates it is necessary to pay special attention to the red, and even the infra-red portions of the spectrum, which are not included in the photographs taken by Uhler & Wood.

Moreover, the dyes used by Uhler & Wood do not include all those in common use, much attention having been paid to the orange and red dyes, while the greens are almost entirely neglected, and the blue dyes have been photographed only to a small extent. For visual work greens are among the most important dye colours.

For these reasons, our laboratory compiled an atlas for themselves, specially adapted for the purpose of selecting dyes for the manufacture of Filters, and when the work was finished it was decided to publish this atlas. We have added to the photographs of dye-stuffs a series of photographs showing the absorptions of some seventy of our own Filters, and we believe that this additional atlas may be of use to those who wish to use filters of a particular kind, and do not want the trouble of preparing their own.

Our best thanks are due to Dr. Roques and Dr. E. Koenig, of the Farbwerke, Hoechst, a/M., both for much direct assistance given, and also for the many valuable new dyes which have been worked out in their laboratories and made available for commerce. Dr. Koenig also read the proofs and revised the list of dyes, supplying much valuable information, including the column giving the Stability to Light.

RESEARCH LABORATORY OF WRATTEN & WAINWRIGHT, LTD.

C. E. KENNETH MEES (*Director*).

MATERIAL.

Most of the dye samples which have been photographed were obtained from the Hoechst Farbwerke, and these are generally pure substances. Those samples which were not chemically pure are indicated in the list by an asterisk. This indication is only to be taken as meaning that the sample used was not specially purified from inorganic salts, it does not mean that the dye cannot be obtained in a pure state. Many of the dyes can be obtained from any dye works, and the origin of some of ours is not known. Where possible, we have shown from where they were obtained. All the dyes were measured in water solution. The Filters represent those which we have in stock. These filters are prepared by coating gelatine solutions of the dye, and after drying, stripping the film from glass. They are standardised by comparison with a standard which is kept, and of which the absorption curve has been measured on a spectro-photometer, a comparison being performed by the aid of a crossing filter which allows only a small portion of the spectrum to be passed, when placed over the portion of the filter to be examined. The tricolour Green filter B, for instance, is tested by means of the tricolour Blue and tricolour Red filters. The test consists of a piece of standard Red and a piece of standard Blue side by side, with the standard piece of Green covering half of each of them. The sheet to be tested is placed so as to cover the other half of each film, and a small deviation from standard can be easily perceived on looking through at a diffused light source. The filters are put on the market as film, and also as prepared filters cemented in glass. They are used for orthochromatic and tricolour photography, photo-micrography, spectroscopy, etc.

Probably this complete list of the standard varieties which we keep will be of considerable use to our readers. We have, of course, a number of variants of these standards, and also some special filters for which the use is limited, and which we have not given here.

APPARATUS.

The spectroscope used was a small box-form spectroscope with a prism grating. The slit was used at a width of about $1/3$ m/m, and a scale was fastened in front of the plate with a yellow film arranged to cut out the ultra-violet of the second order, where it overlapped in the red. The scale was adjusted so that approximate wave-lengths could be read direct on the photographs. The apparatus was arranged with a Nernst lamp, focussed by means of a condenser upon the horizontal slit; in front of the slit was held a wedge cell containing the dye solution to be photographed (Fig. 1). This wedge cell was a rectangular cell of 1 c/m internal length, and 5 m/m internal width, with a diagonal partition which divided it into two wedge-shaped cells. One of these was filled with the dye solution to be photographed, the other contained plain water. In this way the absorption of the dye varied from end to end of the slit; from a very slight thickness of dye to a very considerable thickness, the actual ratio of thickness from end to end of the slit being about 1 to 15.

The photographs of dye spectra therefore show graphically the variation in the absorption with growing thickness of dye, or what is nearly the same thing, with growing concentration.

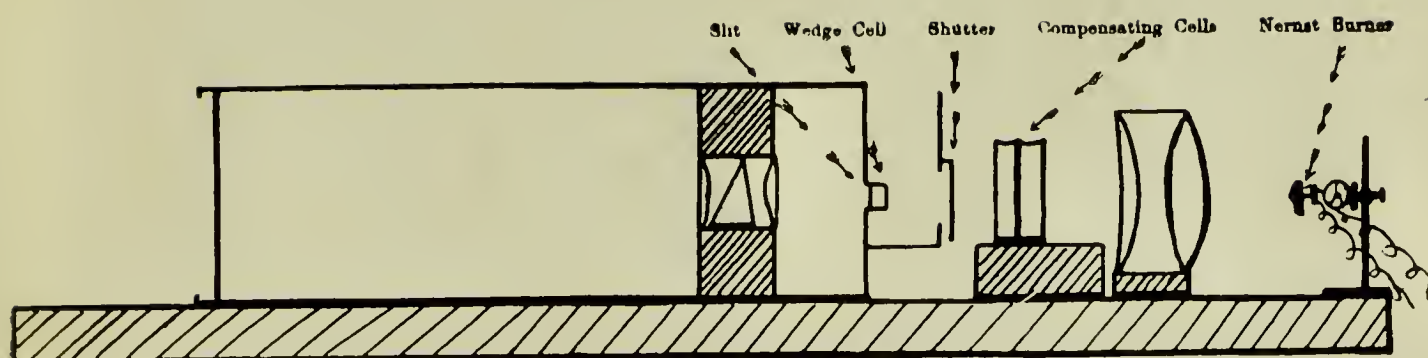


Fig. 1. Arrangement of Spectroscope.

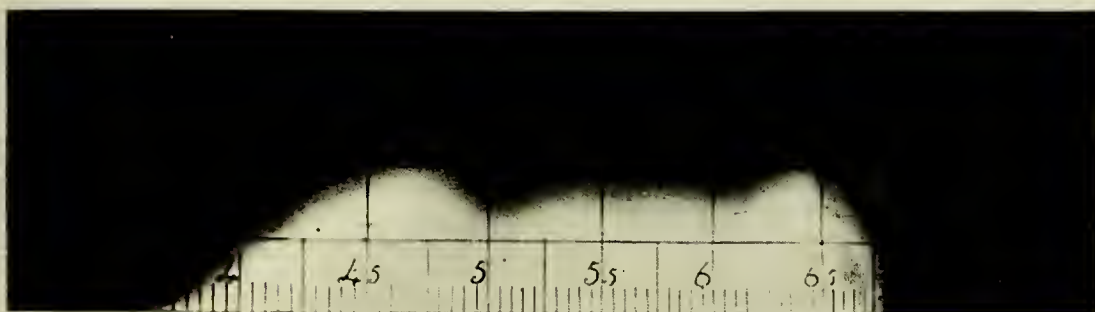


Fig. 2. Wedge Spectrum of Wratten Spectrum Panchromatic Plate.

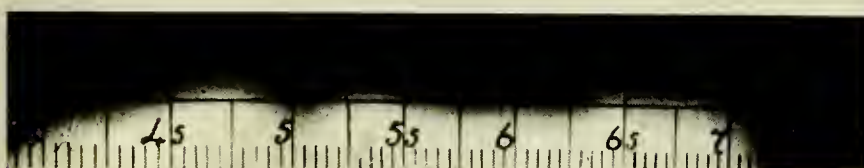


Fig. 3. Black Wedge Spectrum of Screen.

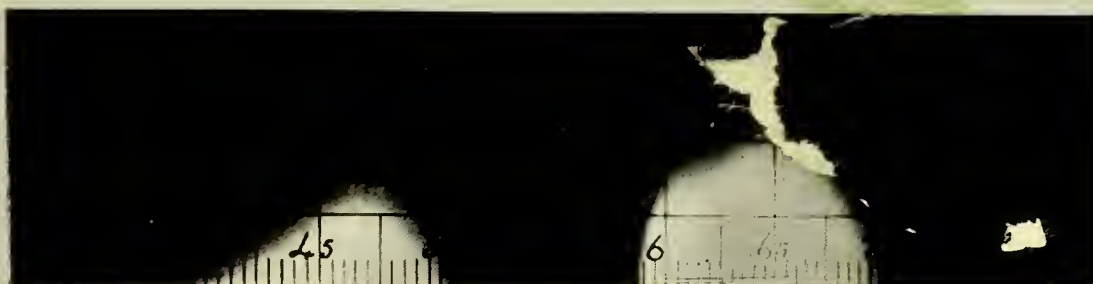


Fig. 4. Black Wedge.

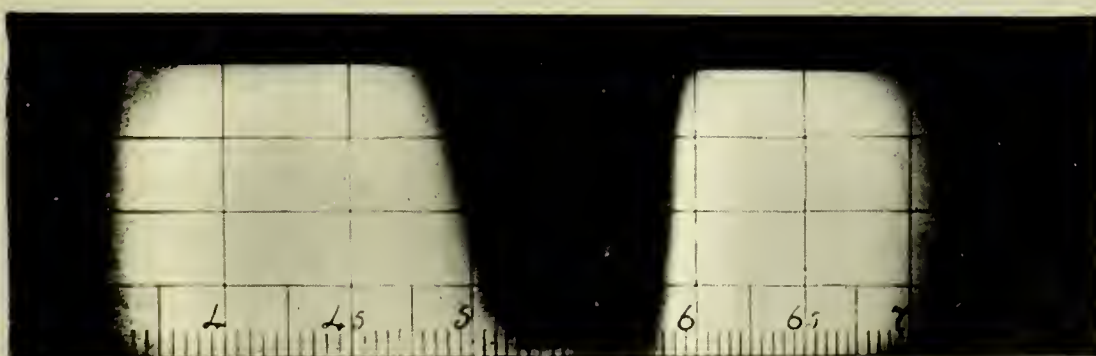


Fig. 4. Dye Wedge.



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THE PLATE AND THE COMPENSATING FILTERS.

We were very desirous in this investigation to use as extended a spectrum as possible, and we particularly required to photograph far into the deep Red and Infra Red. For this reason we used the plate which we manufacture for use in the photography of the extreme and Infra red, and which we term the "Spectrum Panchromatic" plate. This plate, beside the usual maximum in the violet, has a very strong maximum at 6,500 in the Red, and then falls off towards the Infra Red. With long exposures, its sensitiveness extends to 8,000. It will be seen, however, from Fig. 2, which shows its curve to the Nernst lamp, that its distribution of sensitiveness throughout the spectrum is unequal. This was compensated by the introduction of a special screen and two cells containing solutions of Mandarin Orange and P-nitrosodimethylaniline. By this means, a very even spectrum indeed was obtained, extending from about 7,200 to 3,900, and falling off on the one side gradually to 7,500, and on the other 3,500 (Fig. 3).

Two groups of dyes, however, were photographed with other arrangements. The dyes which absorb mainly in the Infra Red, beside being photographed for the whole spectrum, were photographed especially for the Red and Infra Red, a Red screen being used, the Spectrum Panchromatic plate and another special filter enabling us to get records extending to 8,000. The Yellows, on the other hand, were photographed on a plate not sensitive to Red, and with stronger solutions of Mandarin Orange and P-nitrosodimethylaniline, enabling us to get even records to 3,500.

THE SPECTRUM PHOTOGRAPHS OF FILTERS.

With the filters, we were of course unable to use the wedge cell, and in order to get a graphic representation of the variation of their absorption with wave-length, we used the Spectrum Panchromatic plate, adjusted, as before, and fitted a black wedge made of neutral black glass in front of the slit, in the place of the wedge cell. This black glass gives a range of intensity from end to end of the slit of from 1 to 10,000, and the practically useful portion of the gradation has a range of about 1 to 400. On putting a filter in front of this, we get a graphic representation of the intensity of the light coming through; the interpretation of which is to some extent complicated by the fact that it is affected by the sensitiveness curve of the plate. It seems, however, to be the most satisfactory method of automatically representing the curve of a filter.

Fig. 4 shows for comparison purposes the absorption spectrum of a dye wedge of Xylene Red, and the absorption of a cell of the same solution measured by means of a black wedge. It will be seen that while the latter result is not so satisfactory as the dye wedge, it does give a very good idea as to the variation of the transmission of the light in the spectrum.

INDEX OF DYES.

No.	Page.	Name of Dye.	Strength.	Source of Dye.	Acid or Basic.	Stability to Light. (1 represents highest stability, 5 lowest)
1	13	β -Naphtholdisulphonic Acid. R.	1/2,500	H (Höchst)	A	
2	13	β -Naphtholdisulphonic Acid. R.	1/100	H	A	
3	13	Æsculine ...	1/1,000	Merck	A	
4	13	Picric Acid ...	1/100		A	
5	14	Filter Yellow K. ...	1/1,000	H	A	2
6	14	Martius Yellow ...	1/2,500	*	A	
7	14	Aurophenine Ammonia Salt (Chrysophenine) ...	1/1,000	H	A	1-2
8	14	Naphthol Yellow ..	1/1,000	Badische *	A	4-5
9	15	Beizengelb O. 5G.	1/1,000	H	A	
10	15	Pinatype Yellow F.	1/5,000	H	A	2-3
11	15	Thiazole Yellow ...	1/2,500	Bayer *	A	
12	15	Auramine ...	1/10,000	H	B	3
13	16	<i>p</i> -nitrosodimethylaniline ...	1/2,000	H	B	
14	16	Tartrazine ...	1/5,000	Bayer *	A	2-3
15	16	Pinatype Gold Yellow ...	1/5,000	H	A	3-4
16	16	Mandarine Orange	1/10,000	Agfa *	A	
17	17	<i>p</i> -toluchinolinchloraceticester dyestuff	1/1,000	H		5
18	17	Flavophosphine ...	1/10,000	H	B	
19	17	Acridine Orange...	1/5,000	Leonhardt, Mülheim	B	2-3
20	17	Auracine G. ...	1/5,000	Bayer *	A	
21	18	Uranine ...	1/5,000	H *	A	3
22	18	Chrysoidine ...	1/10,000	H	B	
23	18	Chrysoidine ...	1/1,000	H	B	4
24	18	Pinatype Purple ...	1/1,500	H (Mixture)	A	2
25	19	Pinatype Red ...	1/1,500	H	A	1
26	19	Fast Red ...	1/1,000	H	A	3-4
27	19	Rapid Filter Red...	1/2,000	H	A	2
28	19	Rapid Filter Red...	1/1,000	H	A	2
29	20	Rapid Filter Red...	1/200	H	A	
30	20	Complementary Scarlet ...	1/1,500	H	A	
31	20	Complementary Scarlet ...	1/1,000	H	A	
32	20	Complementary Scarlet ..	1/800	H	A	

No.	Page.	Name of Dye.	Strength.	Source of Dye.	Acid or Basic.	Stability to Light.
33	21	Complementary Red 1	1/2,000	H	A	
34	21	Complementary Red 1	1/1,000	H	A	
35	21	Complementary Red D.	1/1,500	H	A	3-4
36	21	Brilliant Carmine C.	1/2,000	Badische	A	
37	22	Crystal Ponceau ...	1/1,000	H	A	3
38	22	Crystal Ponceau ...	1/500	H	A	
39	22	Brilliant Croceine	1/2,000	H	A	
40	22	Coccinine ...	1/1,000	H	A	2
41	23	Alizarine Red ..	1/2,000	H	A	2-3
42	23	Congo Red ...	1/2,000	*	A	
43	23	Congo Red ...	1/1,000	*	A	3-4
44	23	Iodobenzoin 92 ...	1/200	H	A	Not on market
45	24	Azine Scarlet ...	1/500	H	A	
46	24	Fluoresceinate of Sodium (Uranine, pure)	1/1,000	H	A	4-5
47	24	Monobromofluoresceinate of Sodium	1/1,000	H	A	4-5
48	24	Dibromofluoresceinate of Sodium ...	1/1,000	H	A	
49	25	Eosin Yellow Bayer	1/1,000	Bayer *	A	
50	25	Eosin Blue ...	1/1,000		A	
51	25	Tetrabromofluoresceinate of Sodium (Eosin, pure) ...	1/1,000	H	A	5
52	25	Diiodofluoresceinate of Sodium ...	1/1,000	H	A	
53	26	Tetraiodofluoresceinate of Sodium (Erythrosin, pure)	1/1,000	H	A	5
54	26	Scarlet B.B. extra N.	1/1,000	H	A	
55	26	Scarlet B.B. extra B.	1/2,000	H	A	
56	26	Scarlet B.B. extra B.	1/1,000	H	A	
57	27	Tetraiododichlorofluoresceinate of Sodium (Rose Bengal)	1/1,500	H	A	5
58	27	Rose Bengal ...	1/1,000	H	A	5
59	27	Rose Bengal 5 B....	1/4,000	H	A	5
60	27	Rose Bengal 5 B....	1/400	H	A	5
61	28	Cyanosine ...	1/1,000	H	A	5
62	28	Phloxine B.A.Extra	1/1,000	H	A	5
63	28	Phloxine 194 ...	1/1,000	H	A	5

No.	Page.	Name of Dye.	Strength.	Source of Dye.	Acid or Basic.	Stability to Light.
64	28	Phloxine A. ...	1/3,000	H	A	5
65	29	Phloxine Rhodamine	1/1,000	H	B	5
66	29	Rhodamine 6 G....	1/1,000	H	B	3-4
67	29	Tetramethyl Rhodamine	1/2,000	H	B	3-4
68	29	Acid Rhodamine 3 R.	1/1,000	H	A	
69	30	Rhodamine B. ...	1/1,000	Bayer *	B	3-4
70	30	Phenosafranine ...	1/2,000	H	B	
71	30	Xylene Red B. ...	1/2,500	H	A & B	
72	30	Amidonaphthol Red 6 B	1/2,500	H	A	2-3
73	31	Safranine G. ...	1/2,500	H	A	3
74	31	Safranine R. ...	1/2,500	H	A	3
75	31	Pinatype Amaranth	1/1,000	H	A	3-4
76	31	Pinatype Violet ...	1/2,000	H	A	3-4
77	32	Pinatype Carmine	1/2,000	H	A	
78	32	Pinatype Carmine	1/500	H	A	
79	32	Rapid Filter Blue	1/5,000	H	A	2-3
80	32	Rapid Filter Blue	1/1,000	H	A	2-3
81	33	Rosinduline 2 B. Bluish	1/2,500	H	A	
82	33	Acid Violet 4 R....	1/2,500	Badische *	A	2-3
83	33	Acid Violet 4 R....	1/2,000	Badische *	A	2-3
84	33	Chromotrope F. 4B.	1/2,000	H *	A	
85	34	Chromotrope 10 B.	1/2,500	H *	A	
86	34	Acid Chrome Blue 2 R.	1/2,500	H	A	
87	34	Acid Chrome Blue	1/2,500	H *	A	
88	34	Echt Beizenblau ...	1/2,000	H *	A	
89	35	Fuchsine	1/2,500	Bayer *	B	4-5
90	35	Rubin Fuchsine ..	1/2,500	H	B	4-5
91	35	Methyl Violet B.B.R.	1/2,500	H	B	5
92	35	Methyl Violet 6 B.	1/2,500	*	B	5
93	36	Methyl Violet 1 B.	1/16,000	Bayer *	B	5
94	36	Crystal Violet ...	1/10,000	H	B	
95	36	Crystal Violet ...	1/5,000	H	B	
96	36	Gentian Violet ...	1/2,000	Bayer *	B	
97	37	Acid Violet B. N.	1/300	H *	A	4-5
98	37	Acid Violet 4 B. C.	1/2,500	Badische *	A	4-5
99	37	Acid Violet 4 B. C.	1/500	Badische *	A	4-5
100	37	Rhoduline Blue R.	1/2,500	H	B	4-5
101	38	Aniline Blue ...	1/2,500	H *	B	3
102	38	Alkali Blue ...	1/5,000	H *	A	3
103	38	Alkali Blue ...	1/1,000	H *	A	3
104	38	Victoria Pure Blue B.	1/10,000	Badische *	B	

No.	Page.	Name of Dye.	Strength.	Source of Dye.	Acid or Basic.	Stability to Light.
105	39	Victoria Pure Blue B. ...	1/2,000	Badische *	B	
106	39	Victoria Blue B. ...	1/10,000	Badische *	B	4-5
107	39	Victoria Blue B. ...	1/2,500	Badische *	B	4-5
108	39	Victoria Blue B. S.	1/10,000	Badische *	B	4-5
109	40	Victoria Blue B.S.S.	1/10,000	Badische *	B	4-5
110	40	Victoria Blue 4 R.	1/10,000	Badische *	B	4-5
111	40	Victoria Blue 4 R.	1/5,000	Badische *	B	4-5
112	40	Victoria Blue R. ...	1/10,000	Badische *	B	4-5
113	41	Victoria Blue R. ...	1/5,000	Badische *	B	4-5
114	41	Night Blue ...	1/5,000	Badische *	B	
115	41	Night Blue ...	1/2,000	Badische *	B	
116	41	Pinatype Blue ...	1/5,000	H	A	3
117	42	Toluidine Blue ...	1/5,000	H	A	1
118	42	Toluidine Blue (red end only) ...	1/10,000	H	A	
119	42	Toluidine Blue (red end only) ...	1/1,000	H	A	
120	42	Methylene Blue ...	1/10,000	H	B	2-3
121	43	Methylene Blue ...	1/5,000	H	B	2-3
122	43	Methylene Blue (red end only) ...	1/5,000	H	B	2-3
123	43	Thionine Blue ...	1/10,000	H	B	
124	43	Janus Green ...	1/1,000	H *	B	4-5
125	44	Patent Blue A. ...	1/10,000	H	A	3
126	44	Patent Blue A. ...	1/2,500	H	A	3
127	44	Patent Blue V. ...	1/10,000	H	A	3
128	44	Patent Blue V. ...	1/5,000	H	A	3
129	45	Patent Blue V. ...	1/1,000	H	A	3
130	45	Cyanine Blue ...	1/10,000	H	A	3
131	45	Erioglaucine A. ...	1/10,000	Geigy *	A	3
132	45	Erioglaucine A. ...	1/1,000	Geigy *	A	3
133	46	Setoglaucine ...	1/5,000	Geigy *	B	
134	46	Turkish Blue B.B.	1/10,000	Bayer *	A	
135	46	Turkish Blue B.B.	1/1,000	Bayer *	A	
136	46	Methylene Green...	1/5,000	H *	B	2
137	47	Methylene Green...	1/1,000	H *	B	2
138	47	Iodine Green ...	1/10,000	H *	B	5
139	47	Iodine Green ...	1/1,000	H *	B	5
140	47	Fast Green Blue Shade ...	1/1,000	Bayer *	A	
141	48	Complementary Green 1 ...	1/10,000	H	A	4
142	48	Complementary Green 1 ...	1/1,000	H	A	4
143	48	Solid Green ...	1/1,000	Bayer	A	

No.	Page.	Name of Dye.	Strength.	Source of Dye.	Acid or Basic.	Stability to Light.
144	48	New Solid Green 3 B.	1/10,000	H	A	
145	49	New Solid Green 3 B.	1/1,000	H	A	
146	49	Naphthaline Green	1/10,000	H	A	3-4
147	49	Naphthaline Green	1/1,000	H	A	3-4
148	49	Rapid Filter Green	1/10,000	H	A	3
149	50	Rapid Filter Green	1/1,000	H	A	3
150	50	Acid Green ...	1/5,000	H *	A	4
151	50	Acid Green ...	1/1,000	H *	A	4
152	50	Emerald Green ...	1/1,000	Bayer *	B	
153	51	Brilliant Green ...	1/5,000	*	B	4
154	51	Diamond Green ...	1/10,000	Badische *	B	
155	51	Diamond Green ...	1/1,000	Badische *	B	
156	51	Victoria Green 1...	1/10,000	Bayer *	B	
157	52	Victoria Green 1...	1/1,000	Bayer *	B	
158	52	Eboli Green ...	1/1,000	Leonhardt *	A	
159	52	Naphthol Green (red end only) ...	1/5,000	H	<u>A</u>	1-2
160	52	Naphthol Green (red end only) ...	1/1,000	H	A	1-2
161	53	Naphthol Green ...	1/1,000	H	A	1-2
162	53	Naphthol Green 2·6 (red end only) ...	1/2,500	H	A	
163	53	Naphthol Green 2·6	1/1,000	H	A	
164	53	Pinatype Green M (red end only) ...	1/5,000	H	A	1
165	54	Pinatype Green M	1/1,000	H	A	1
166	54	Toluidine Green (red end only) ...	1/2,000	H	A	1
167	54	Filter Blue Green	1/1,000	H	A	3-4
168	54	Filter Blue Green (red end only) ...	1/500	H	A	3-4
169	55	Filter Blue Green (red end only) ...	1/200	H	A	3-4
170	55	Filter Blue Green (red end only) ...	1/100	H	A	3-4

INDEX OF FILTERS.

No.	Page.	Name of Filter.	No.	Page.	Name of Filter.
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2	56	Æsculine	41	66	Blue 363
3	56	Picric Acid "D"	42	66	Blue 445
4	56	Picric Acid "C"	43	66	Minus Red 2
5	57	Picric Acid "B"	44	66	Minus Red 4. Standard Complementary
6	57	Picric Acid "A"	45	67	H. M.
7	57	K1	46	67	η Blue
8	57	K2	47	67	C (light)
9	58	K3. M.	48	67	Ci. M. Standard Tricolour
10	58	Tartrazine 1	49	68	C2
11	58	Tartrazine 2	50	68	Mercury Violet. Mercury Monochromat
12	58	Minus Blue. Standard Complementary			(Contrast "L")
13	59	G.A. 1	51	68	Naphthol Green 1
14	59	G.A. 4	52	68	Naphthol Green 2
15	59	G. M.	53	69	Naphthol Green 3
16	59	Flavazine T.	54	69	Naphthol Green 4
17	60	<i>p</i> -nitrosodimethylaniline	55	69	Stereo Green
18	60	Ultraviolet Filter	56	69	B3
19	60	Mandarine Orange	57	70	B2 (light)
20	60	Monobromofluoresceine (light)	58	70	B2
21	61	Monobromofluoresceine (dark)	59	70	B. M. Standard Tricolour Green
22	61	E2. M.	60	70	δ Green (Contrast "P")
23	61	E1	61	71	Additive Green (Contrast "N")
24	61	E. (red)	62	71	Mercury Green. Mercury Monochromat
25	62	A. M. Standard Tricolour	63	71	ϵ Green
26	62	Stereo Red.	64	71	Minus Red 3 (light)
27	62	F1	65	72	Minus Red 3
28	62	F2	66	72	Rapid Filter Green
29	63	F3. M.	67	72	γ Green 2
30	63	Rose Bengal	68	72	γ Green 3
31	63	Minus Green 1	69	73	γ Green 4
32	63	Minus Green 3. Standard Complementary	70	73	α (Monochromat) (Contrast "R")
33	64	Xylene Red	71	73	β (Monochromat)
34	64	D (light)	72	73	γ (Monochromat)
35	64	D. M.	73	74	δ (Monochromat)
36	64	Methyl Violet B.B.R.	74	74	ϵ (Monochromat)
37	65	β Blue	75	74	η (Monochromat)
38	65	β Blue (dark)	76	74	θ (Monochromat)
39	65	Blue 203			

SPECIAL SERIES OF FILTERS INCLUDED IN THE FILTER LIST.

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			K3	9	58
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			Green	59	70
			Blue	48	67
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			B	59	70
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			D	35	64
			E	22	61
			F	29	63
			G	15	59
			H	45	67
			K3	9	58
Monochromats	α	70	73
			β	71	73
			γ	72	73
			δ	73	74
			ϵ	74	74
			η	75	74
			θ	76	74
Mercury Vapour Lamp Mono- chromats			Green	62	71
			Yellow (E.2.)	22	61
			Violet	50	68
Contrast Filters not included in "M" set			L (Violet)	50	68
			N (Pure Green)	61	71
			P (Blue Green)	60	70
			R (Deep Red)	70	73



Dyes.

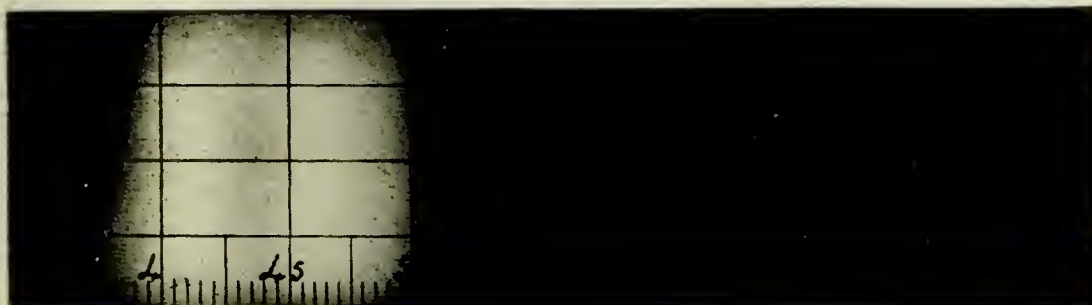


Fig. 1 β -Naphtholdisulphonic Acid R. 1/2,500 (Blue end only).



Fig. 2 β -Naphtholdisulphonic Acid R. 1/100 (Blue end only).

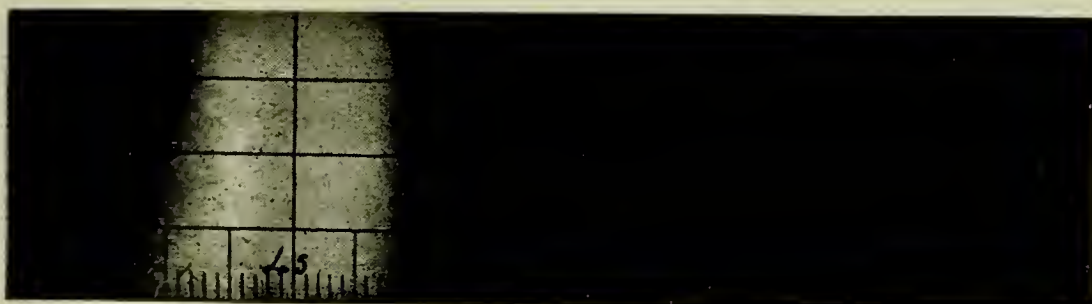


Fig. 3 *Æsculine* 1/1,000 (Blue end only).

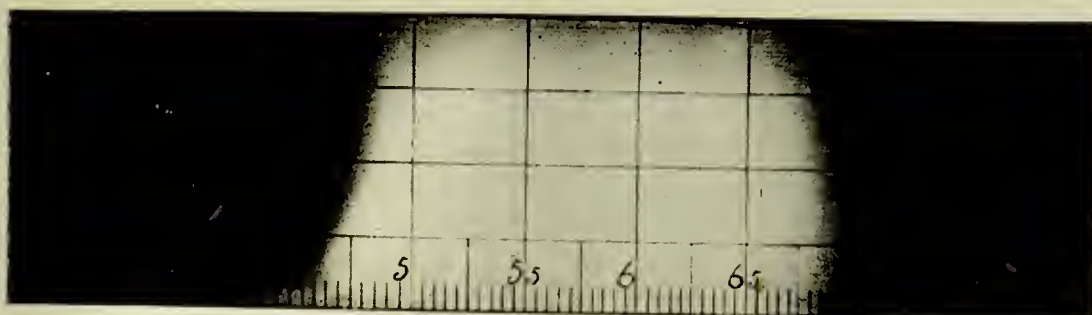


Fig. 4 *Pieric Acid* 1/100.



Fig. 5. Filter Yellow K. 1/1,000 (Blue end only).

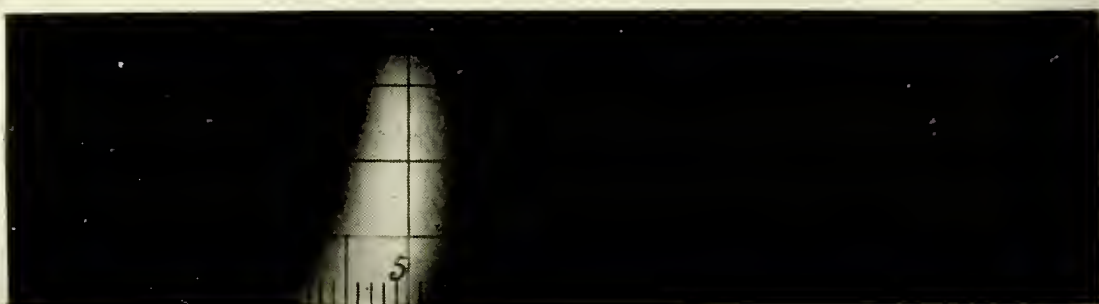


Fig. 6 Martius Yellow 1/2,500 (Blue end only).



Fig. 7. Aurophenine Ammonia Salt 1/1,000 (Blue end only).



Fig. 8. Naphthol Yellow 1/1,000 (Blue end only).



Fig. 9. Beizengelb O. 5 G. 1/1,000 (Blue end only).



Fig. 10. Pinatype Yellow F. 1/5,000 (Blue end only).

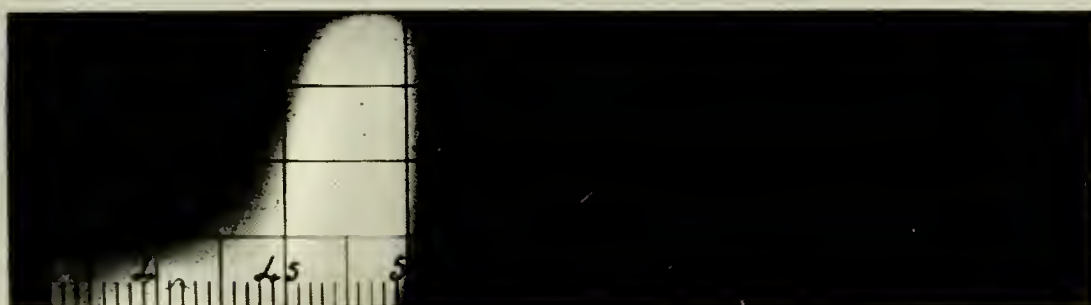


Fig. 11. Thiazole Yellow 1/2,500 (Blue end only).

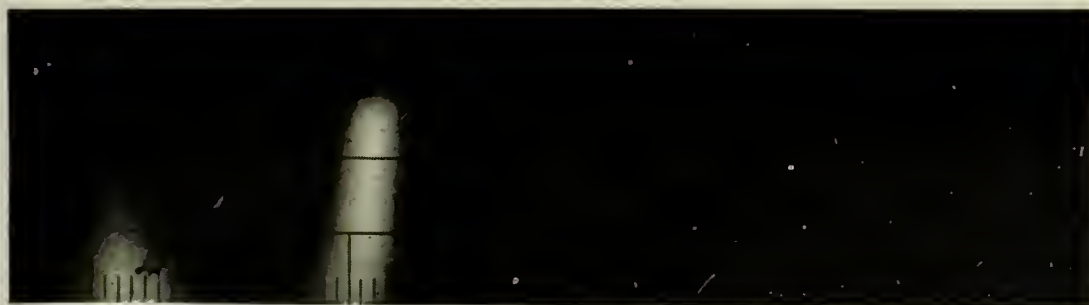


Fig. 12. Auramine 1/10,000 (Blue end only).



Fig. 13. *p*-nitrosodimethylaniline 1/2,000 (Blue end only).

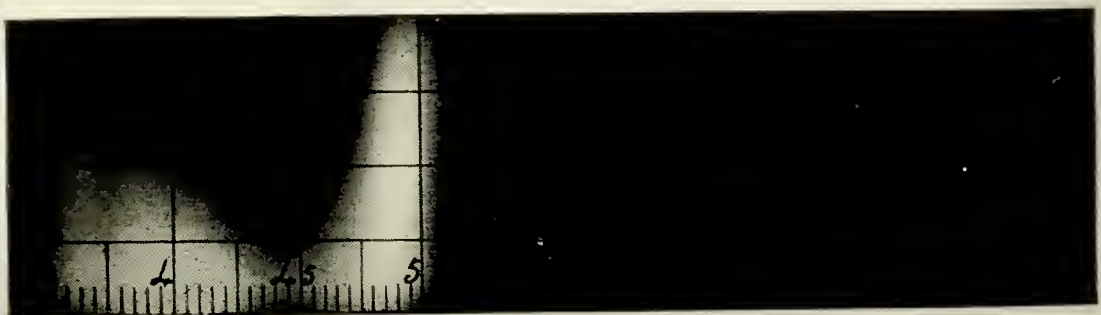


Fig. 14. Tartrazine 1/5,000 (Blue end only).



Fig. 15. Pinatype Gold Yellow 1/5,000 (Blue end only).



Fig. 16. Mandarin Orange 1/10,000 (Blue end only).

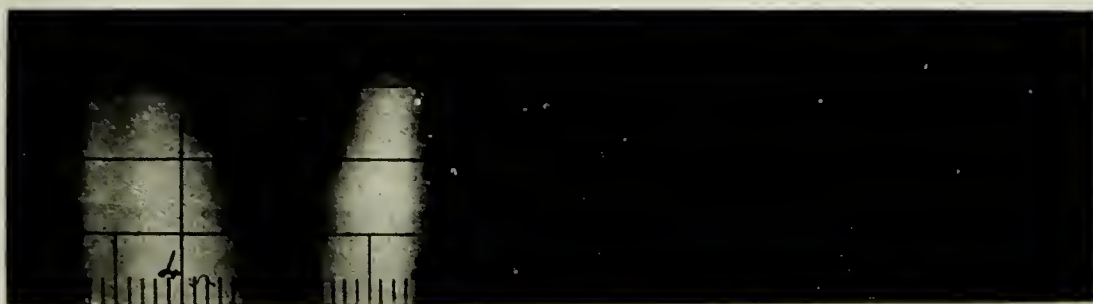


Fig. 17. *p*-toluchinolinchloracetic ester dyestuff 1/1,000 (Blue end only).

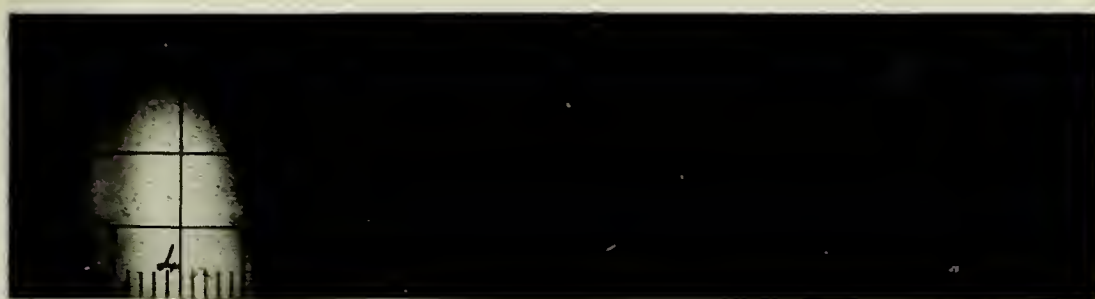


Fig. 18. Flavophosphine 1/10,000 (Blue end only).

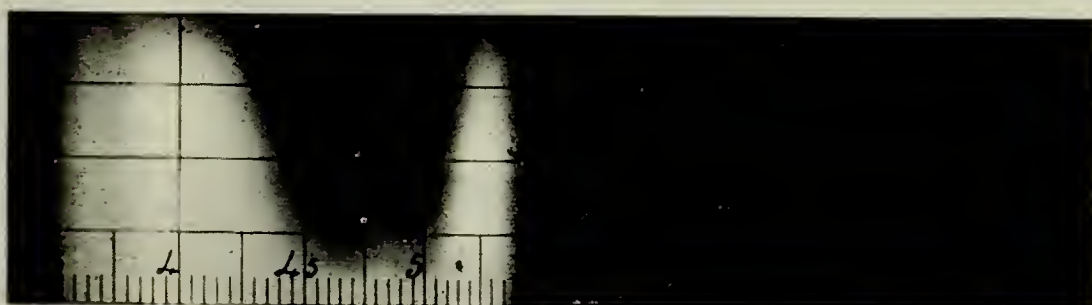


Fig. 19. Acridine Orange 1/5,000 (Blue end only).

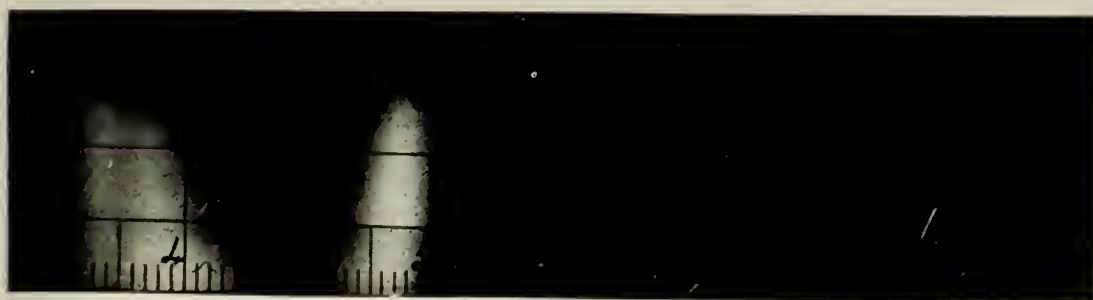


Fig. 20. Auracine G. 1/5,000 (Blue end only).



Fig. 21. Uranine 1/5,000 (Blue end only).



Fig. 22. Chrysoidine 1/10,000 (Blue end only).

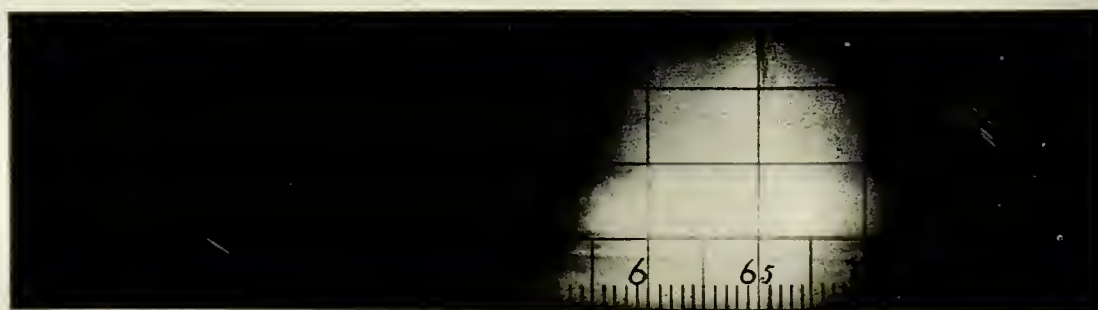


Fig. 23. Chrysoidine 1/1,000.

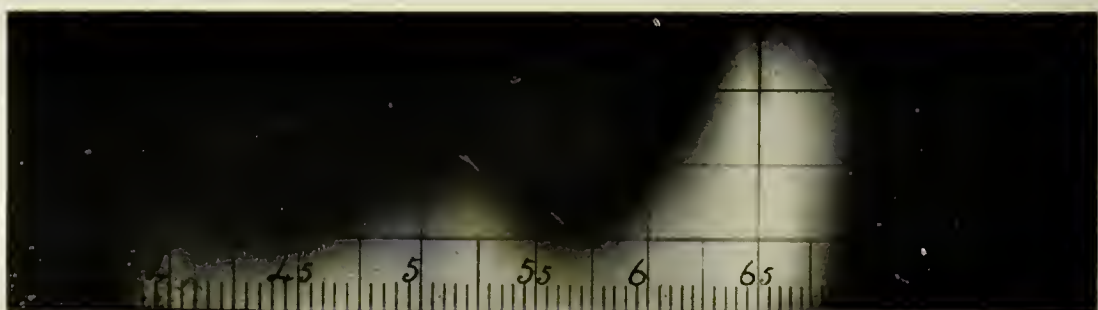


Fig. 24. Pinatype Purple 1/1,500.

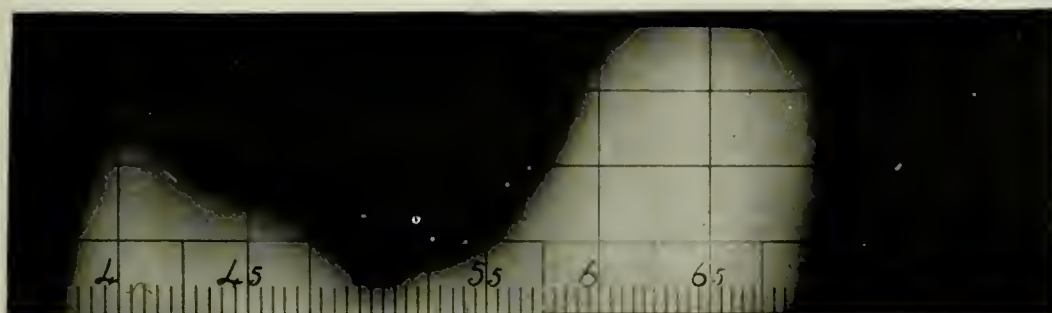


Fig. 25. Pinatype Red 1/1,500

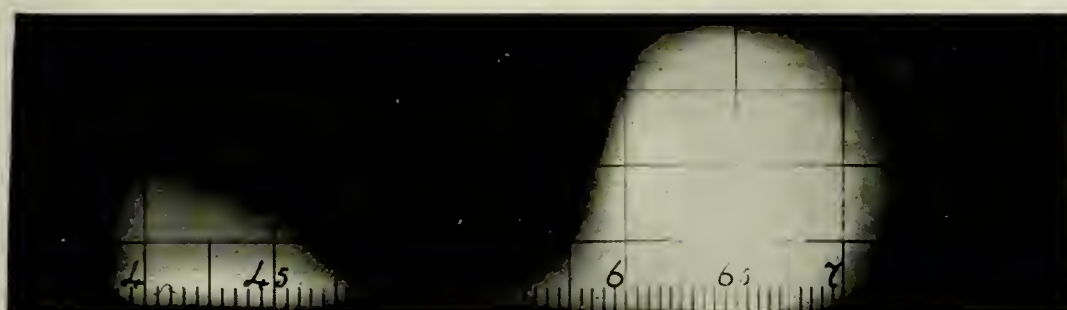


Fig. 26. Fast Red 1/1,000.



Fig. 27. Rapid Filter Red 1/2,000

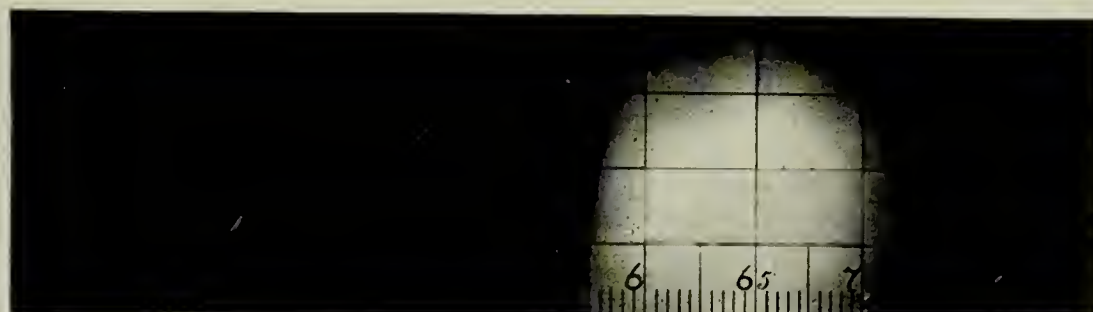


Fig. 28. Rapid Filter Red 1/1,000.



Fig. 29. Rapid Filter Red $1/200$.

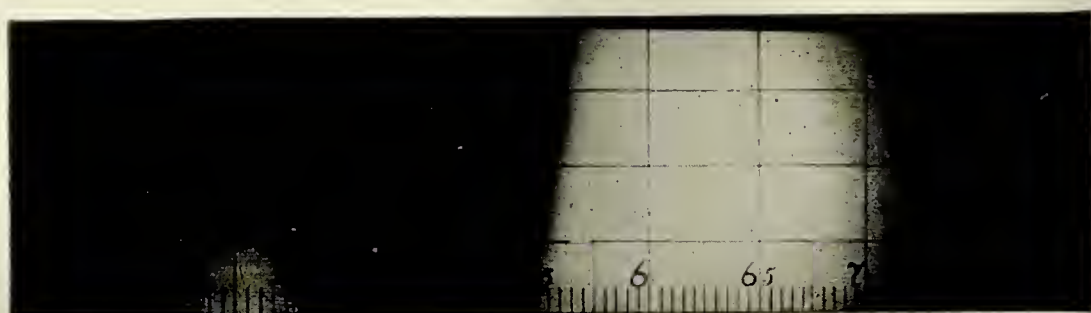


Fig. 30. Complementary Scarlet $1/1,500$.

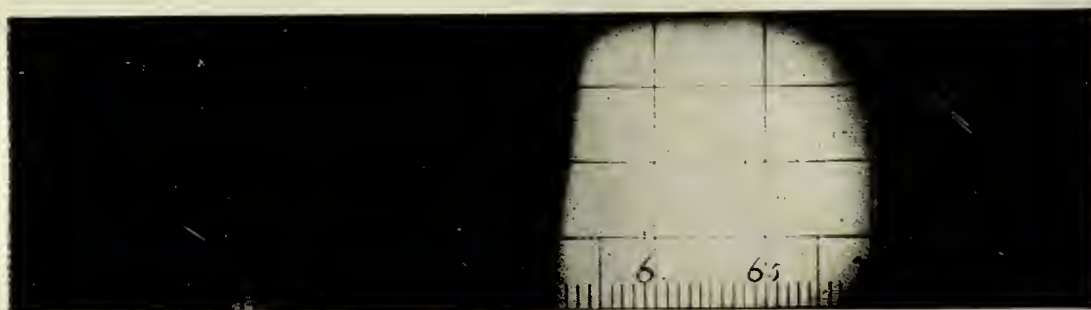


Fig. 31. Complementary Scarlet $1/1,000$.

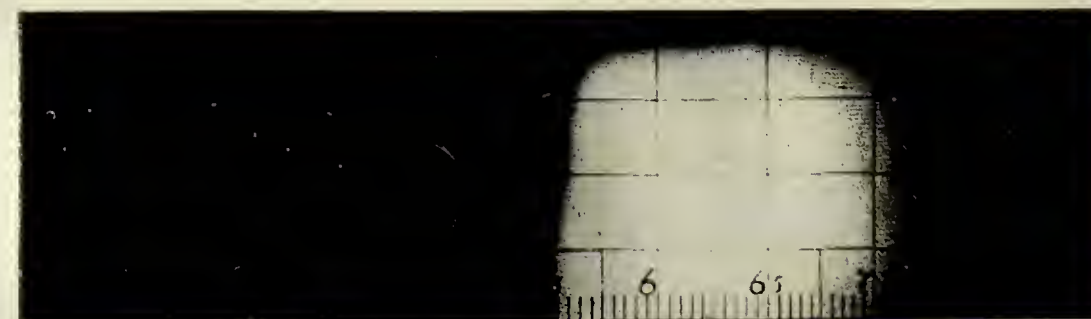


Fig. 32. Complementary Scarlet $1/800$.

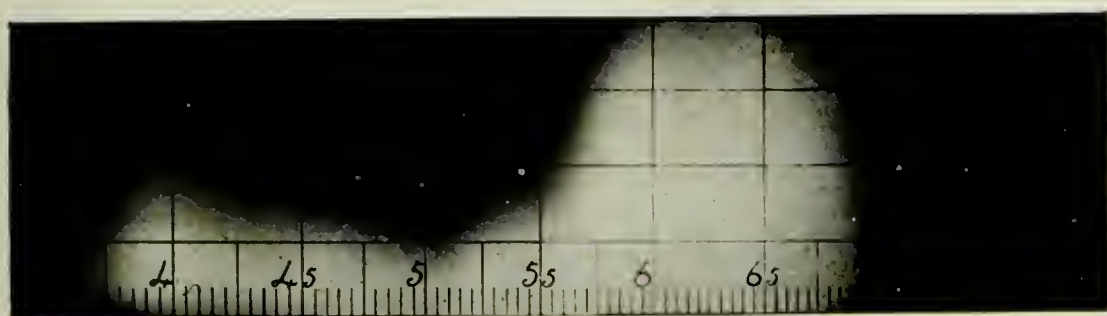


Fig. 33. Complementary Red 1. $1/2,000$



Fig. 34. Complementary Red 1. $1/1,000$.

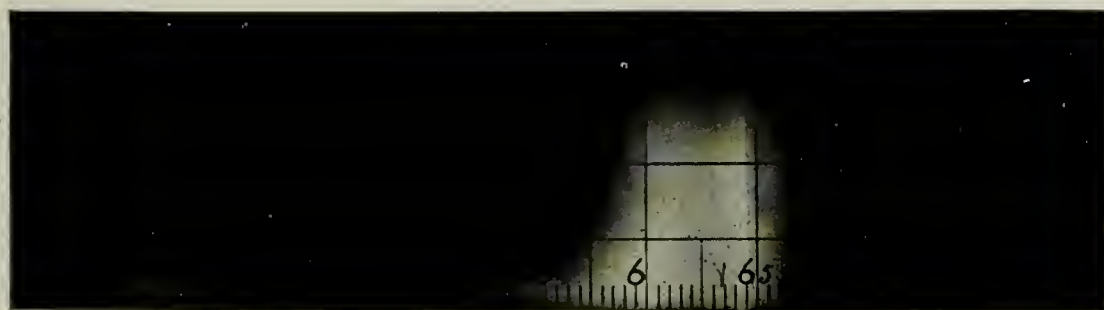


Fig. 35. Complementary Red D. $1/1,500$.

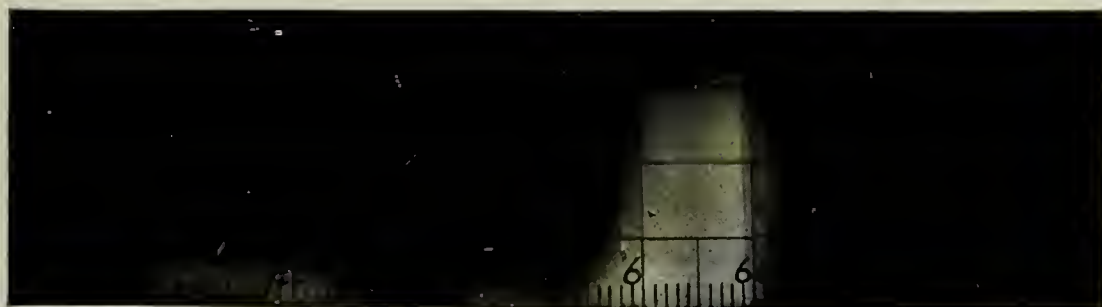


Fig. 36. Brilliant Carmine C. $1/2,000$.

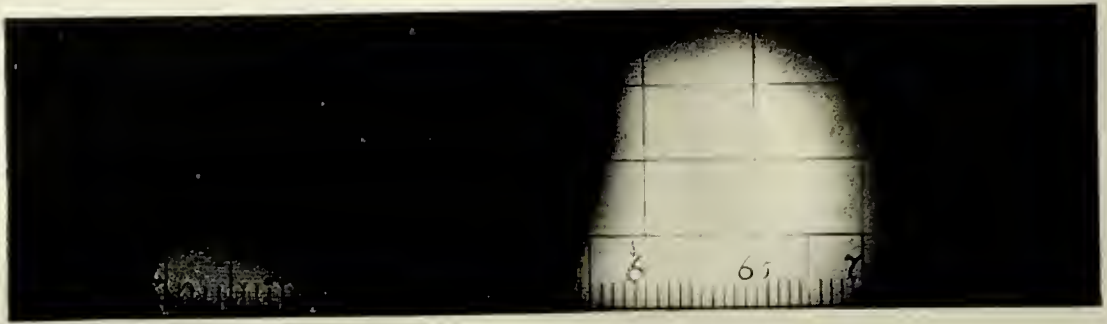


Fig. 37. Crystal Ponceau 1/1,000.

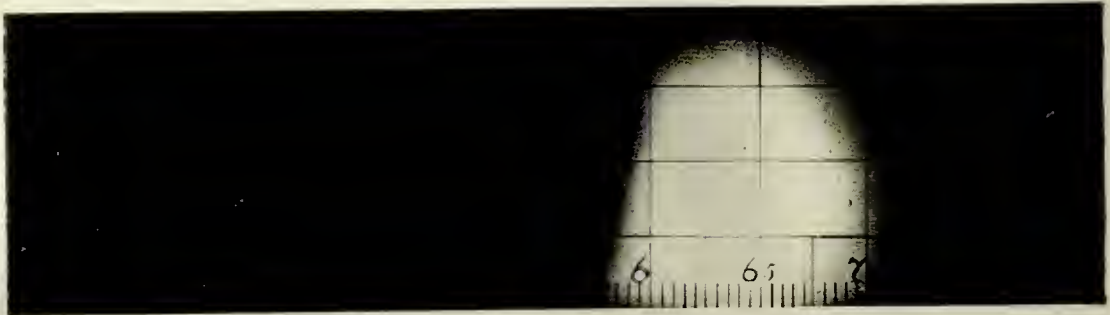


Fig. 38. Crystal Ponceau 1/500.

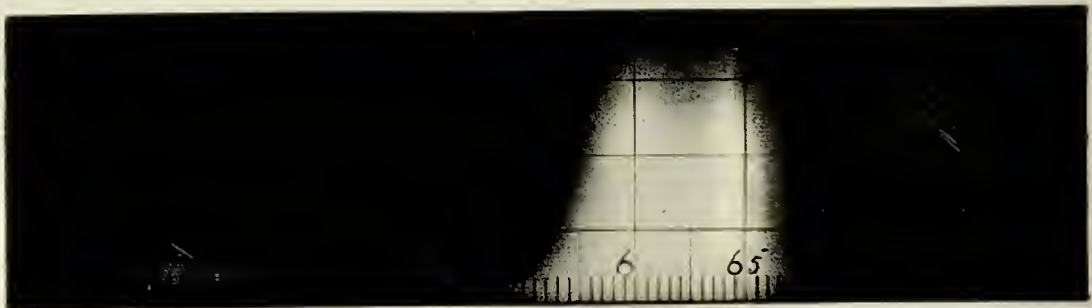


Fig. 39. Brilliant Croceine 1/2,000

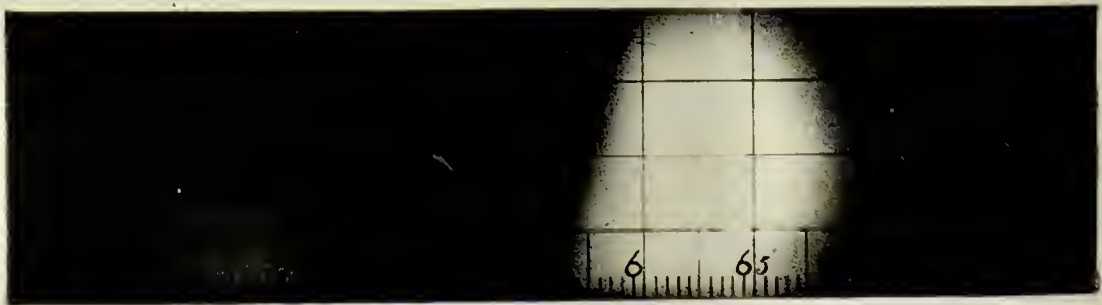


Fig. 40. Coccinine 1/1,000.

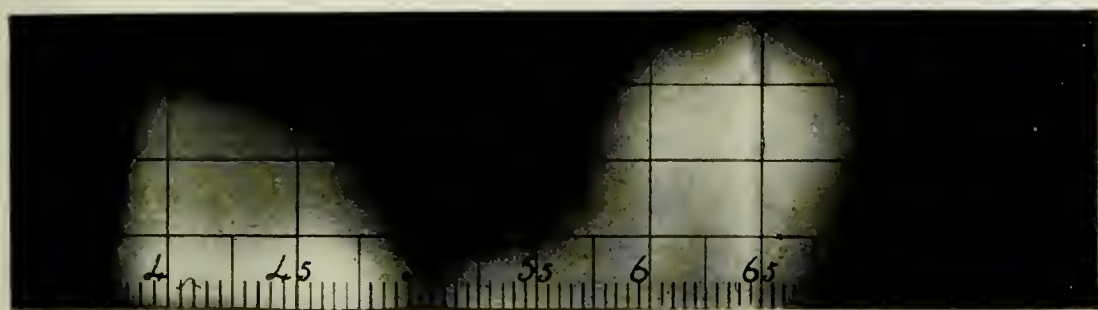


Fig. 41. Alizarine Red 1/2,000.

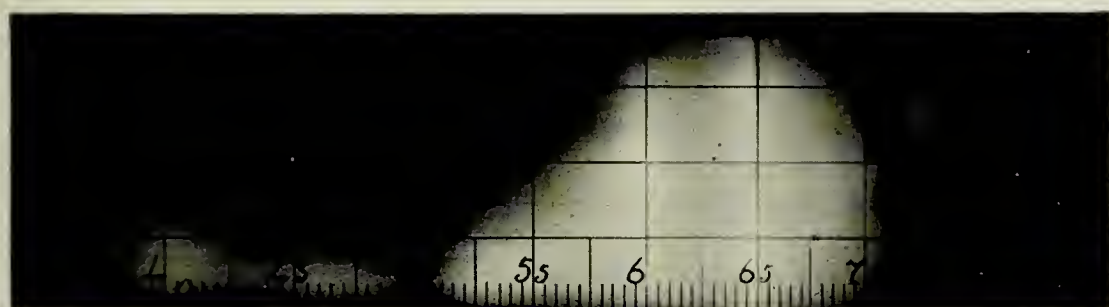


Fig. 42. Congo Red 1/2,000.

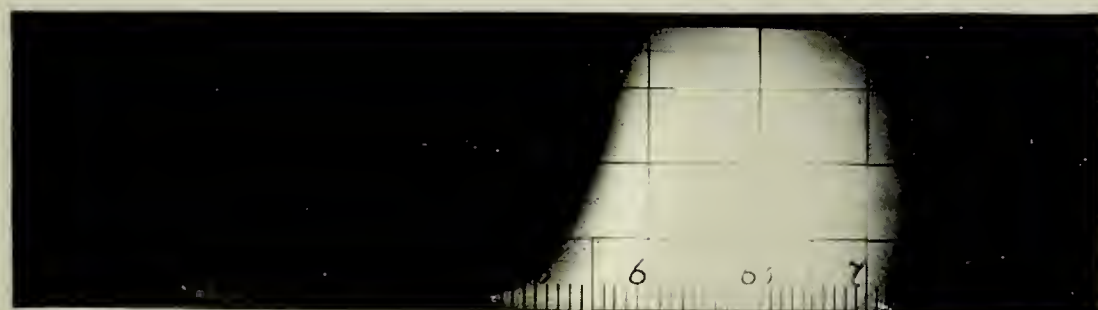


Fig. 43. Congo Red 1/1,000.

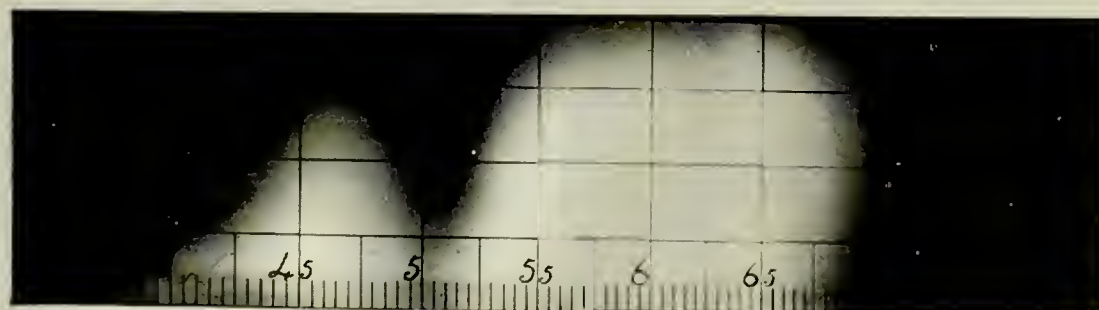


Fig. 44. Iodobenzoin 92. 1/200.

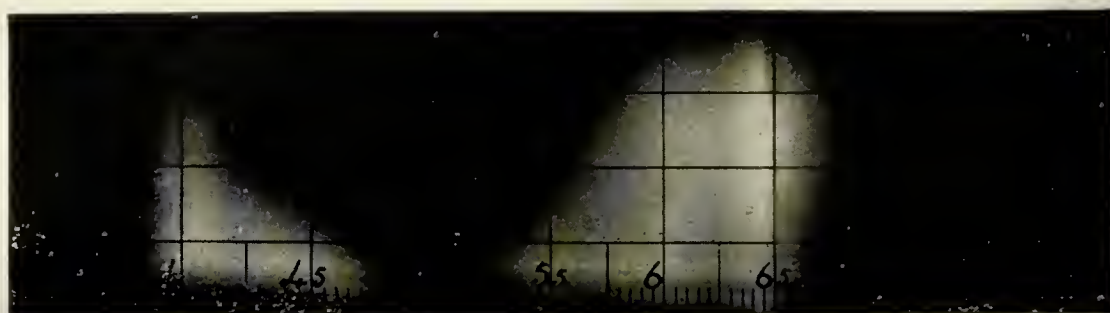


Fig. 45. Azine Scarlet 1/500.

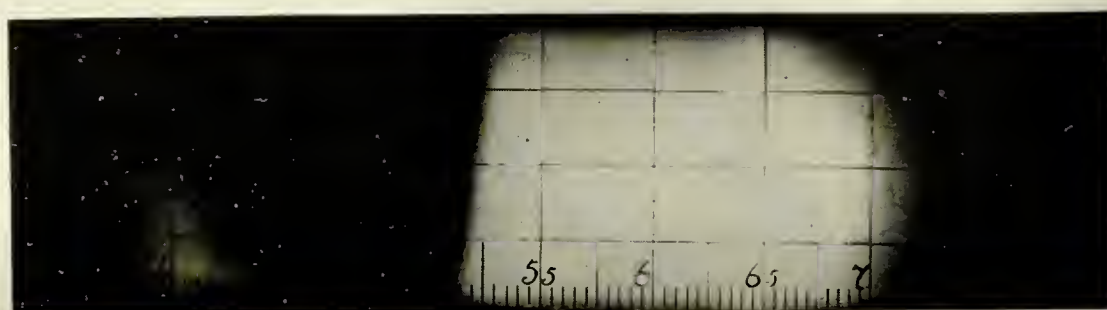


Fig. 46. Fluoresceinate of Sodium 1/1,000.

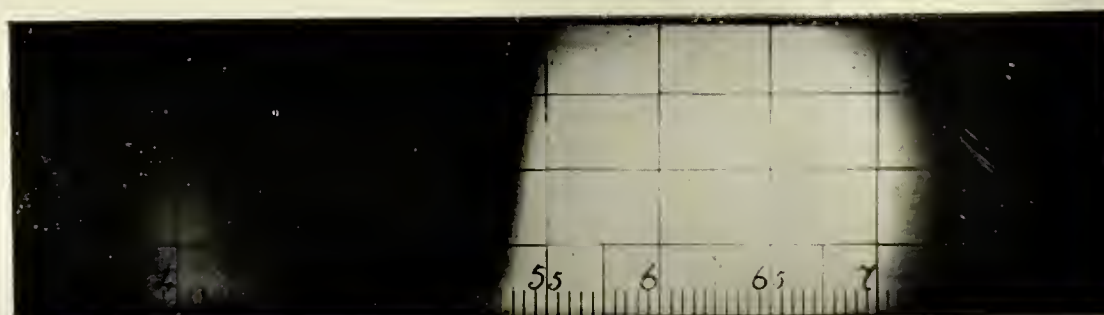


Fig. 47. Monobromofluoresceinate of Sodium 1/1,000.

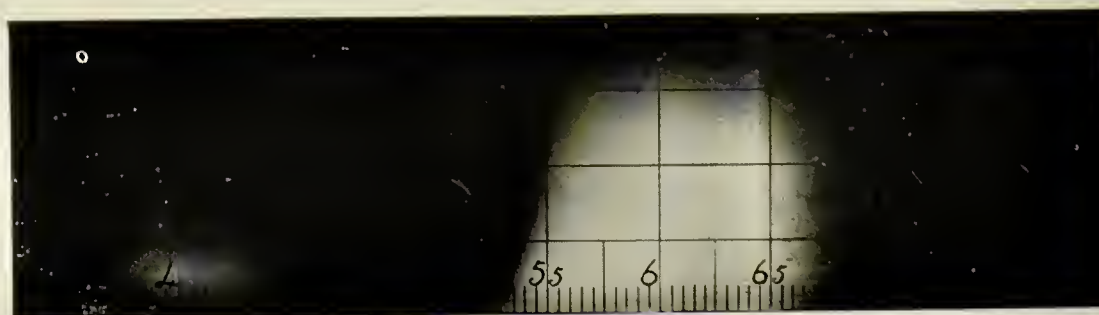


Fig. 48. Dibromofluoresceinate of Sodium 1/1,000.

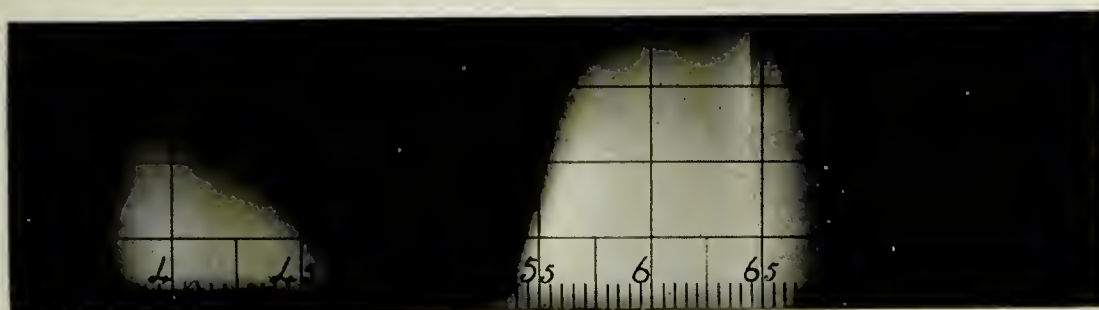


Fig. 49. Eosine Yellow Bayer 1/1,000.

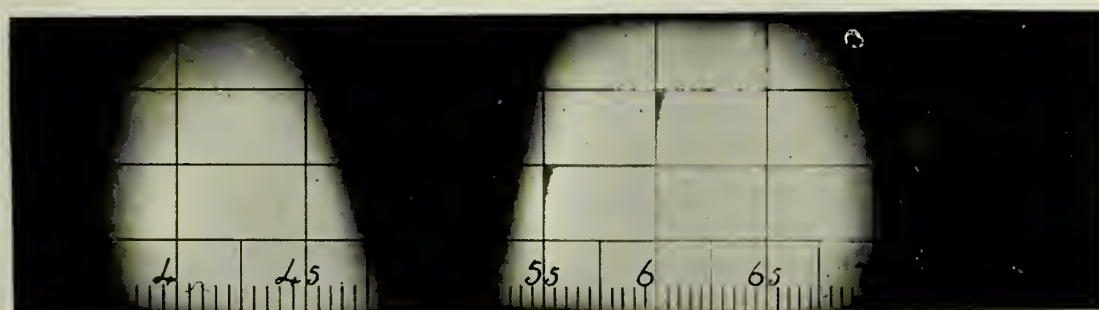


Fig. 50. Eosine Blue 1/1,000.

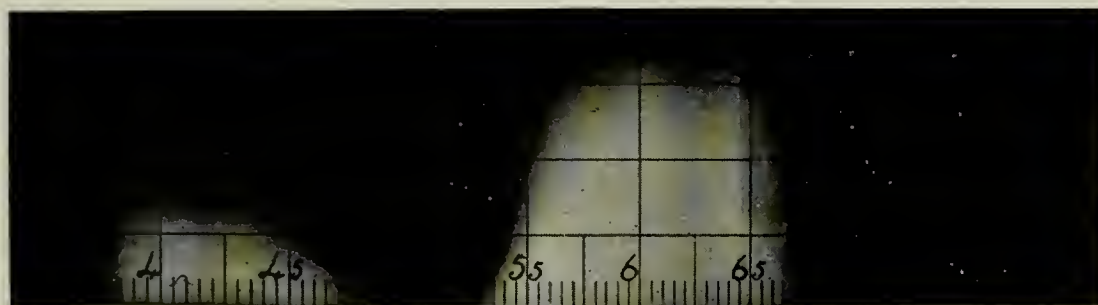


Fig. 51. Tetrabromofluoresceinate of Sodium 1/1,000.

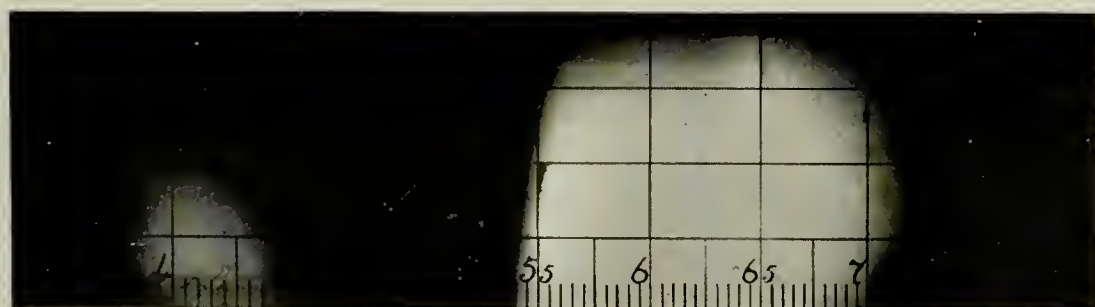


Fig. 52. Diiodofluoresceinate of Sodium 1/1,000.

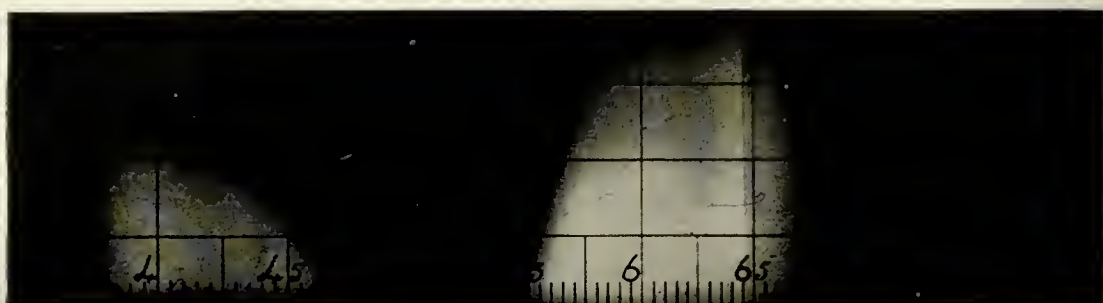


Fig. 53. Tetraiodofluoresceinate of Sodium 1/1,000.

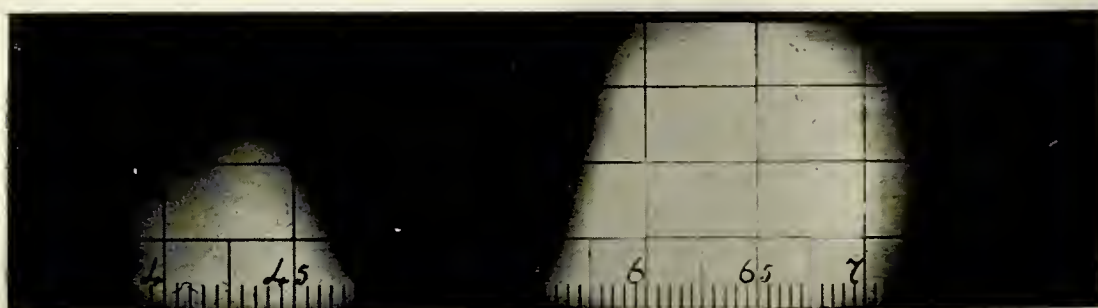


Fig. 54. Scarlet B.B. extra N. 1/1,000.

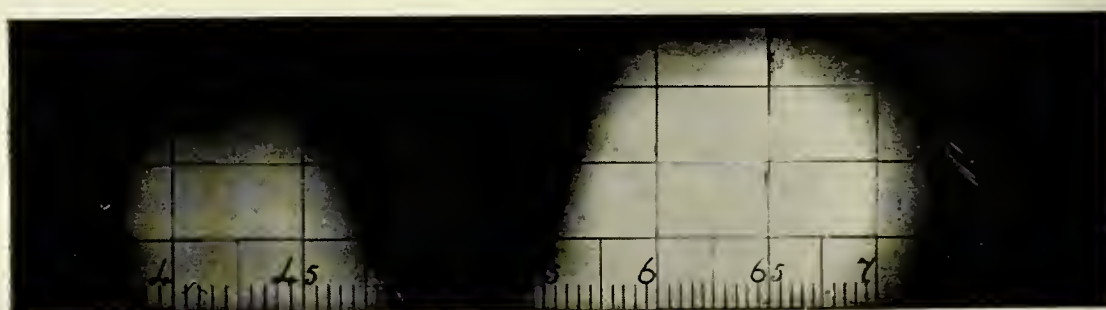


Fig. 55. Scarlet B.B. extra B. 1/2,000.

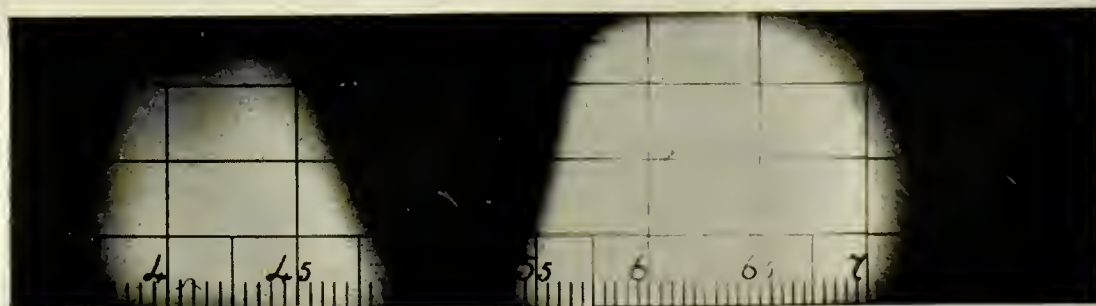


Fig. 56. Scarlet B.B. extra B. 1/1,000.

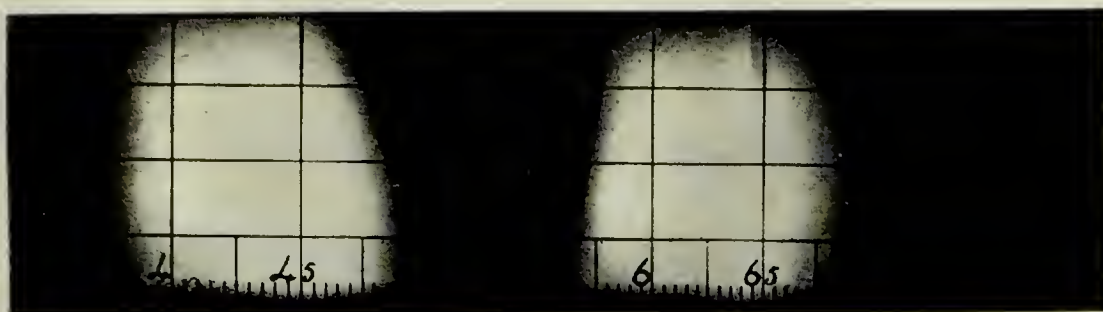


Fig. 57. Rose Bengal 1/1,500.



Fig. 58. Rose Bengal 1/1,000.

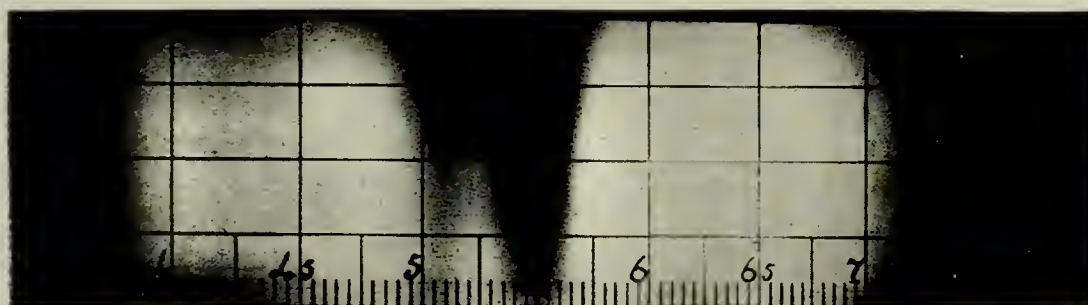


Fig. 59. Rose Bengal 5 B. 1/4,000.

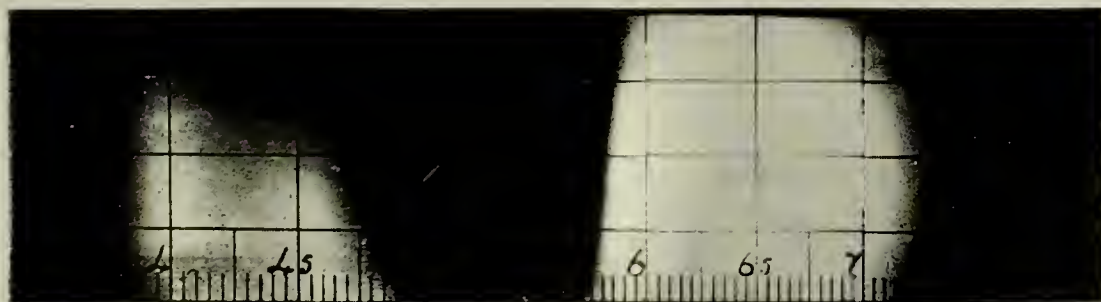


Fig. 60. Rose Bengal 5 B. 1/400.

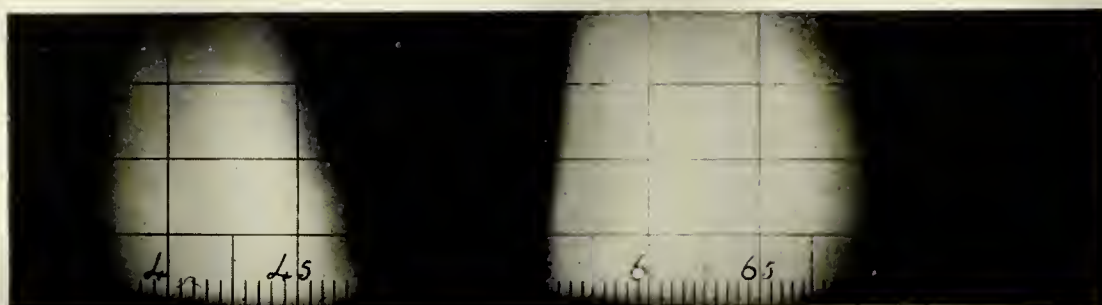


Fig. 61. Cyanosine 1/1,000.

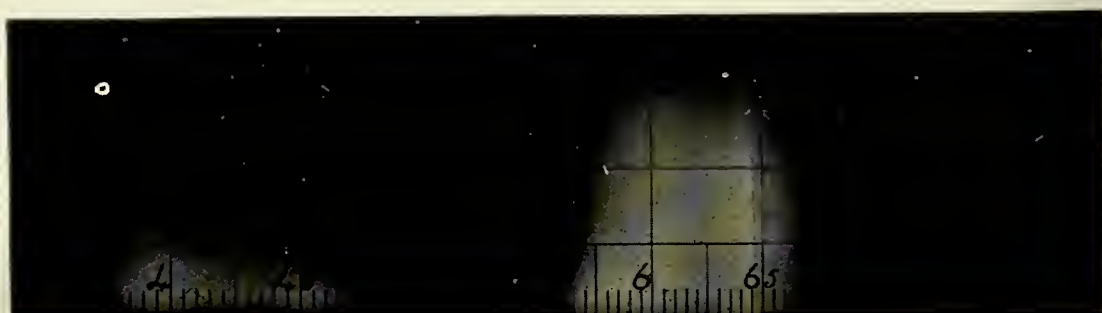


Fig. 62. Phloxine B.A. Extra 1/1,000.

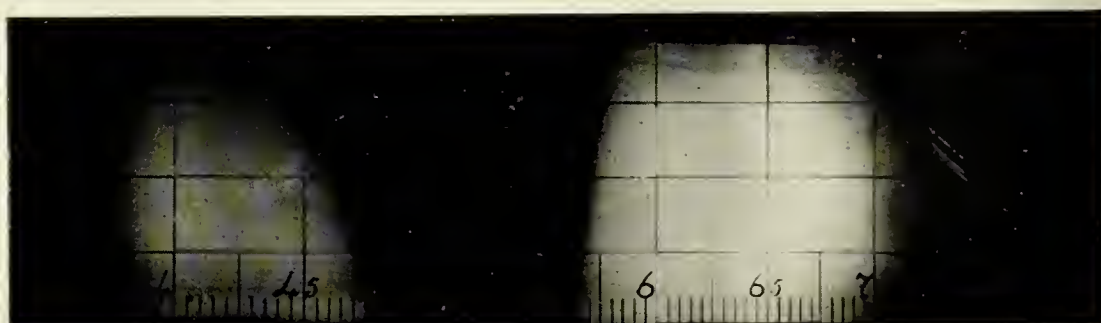


Fig. 63. Phloxine 194. 1/1,000.

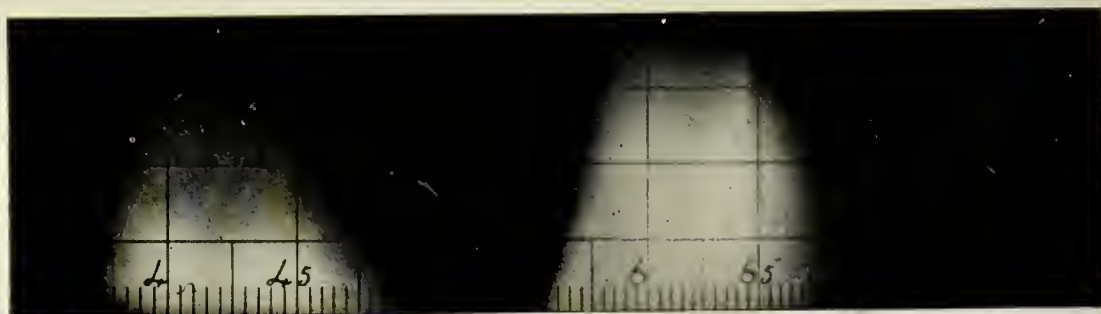


Fig. 64. Phloxine A. 1/3,000.

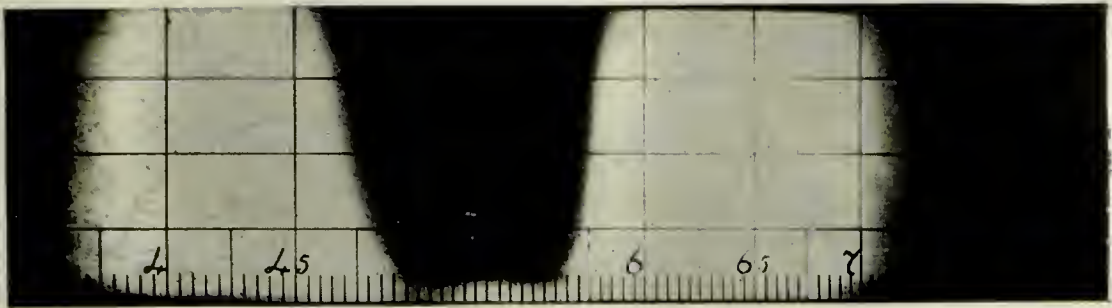


Fig. 65. Phloxine Rhodamine 1/1,000.

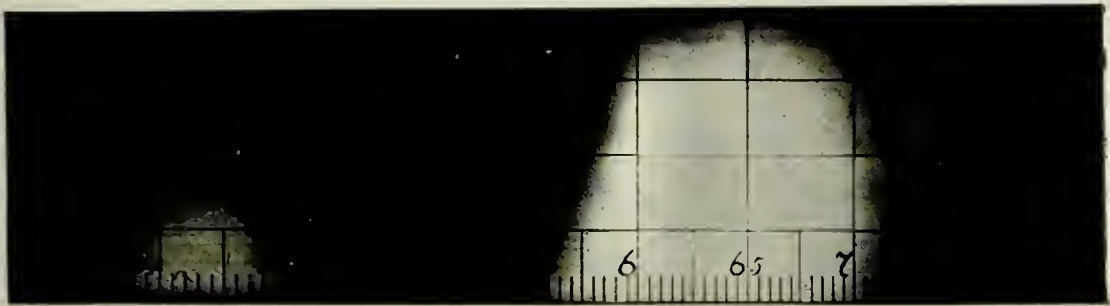


Fig. 66. Rhodamine 6 G. 1/1,000.

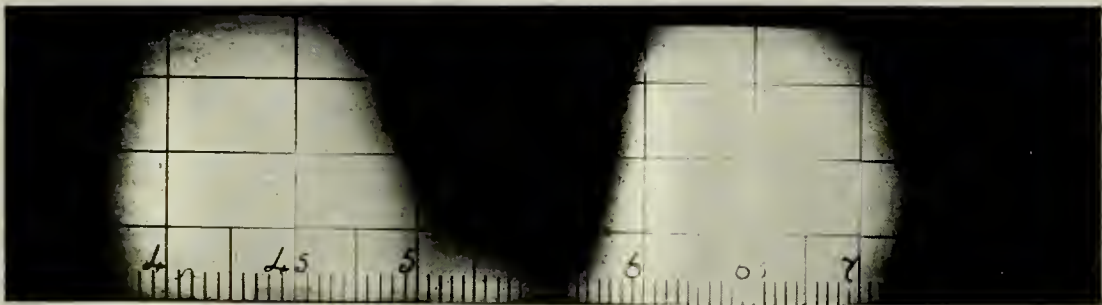


Fig. 67. Tetramethyl Rhodamine 1/2,000.

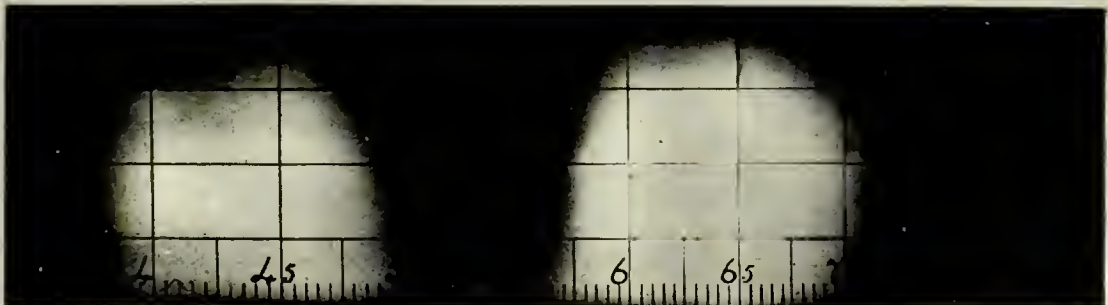


Fig. 68. Acid Rhodamine 3 R. 1/1,000.

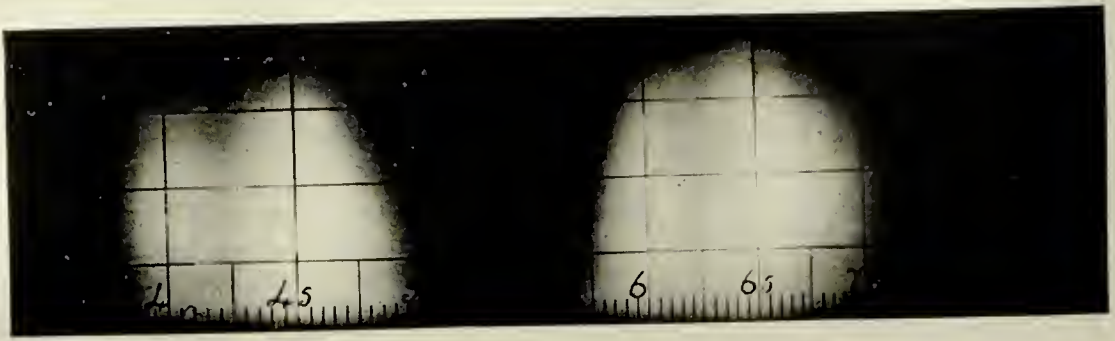


Fig. 69. Rhodamine B. 1/1,000.

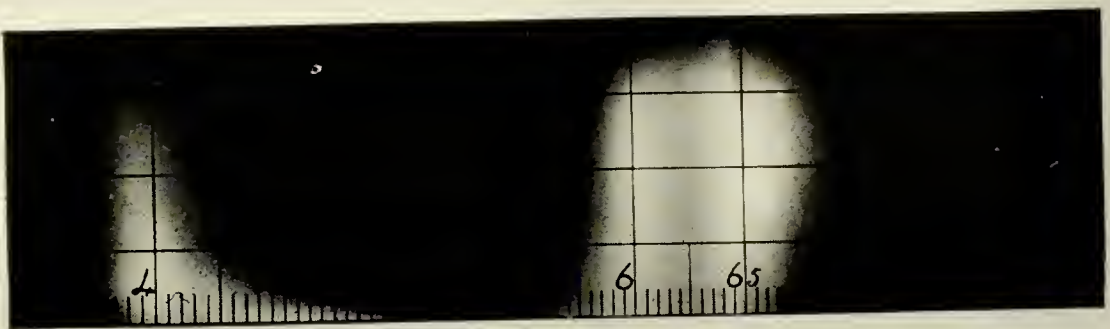


Fig. 70. Phenosafranin 1/2,000.

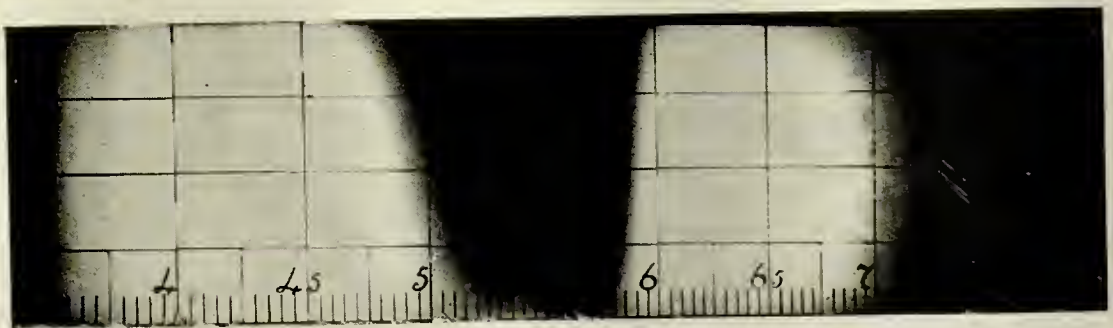


Fig. 71. Xylene Red B. 1/2,500.



Fig. 72. Amidonaphthol Red 6 B. 1/2,500.

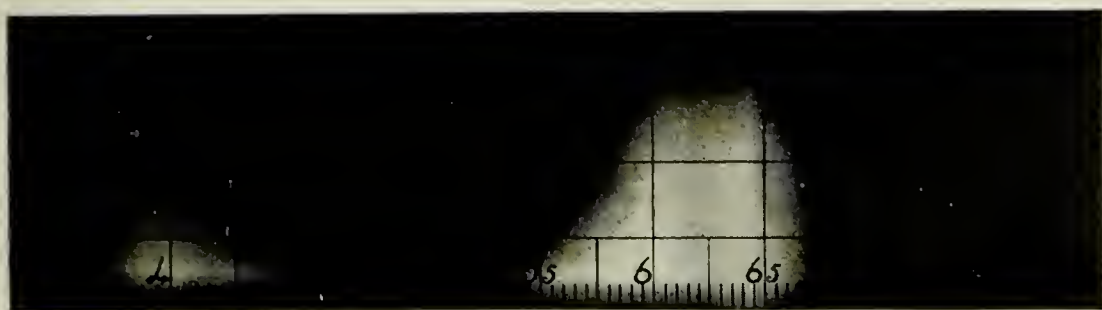


Fig. 73. Safranin G. 1/2,500.

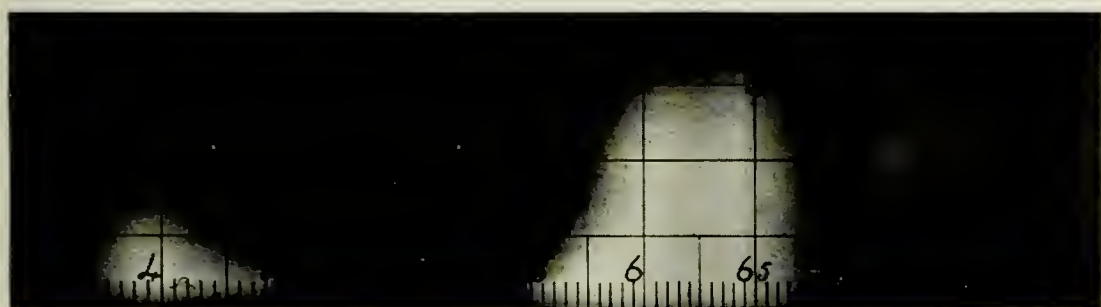


Fig. 74. Safranin R. 1/2,500.

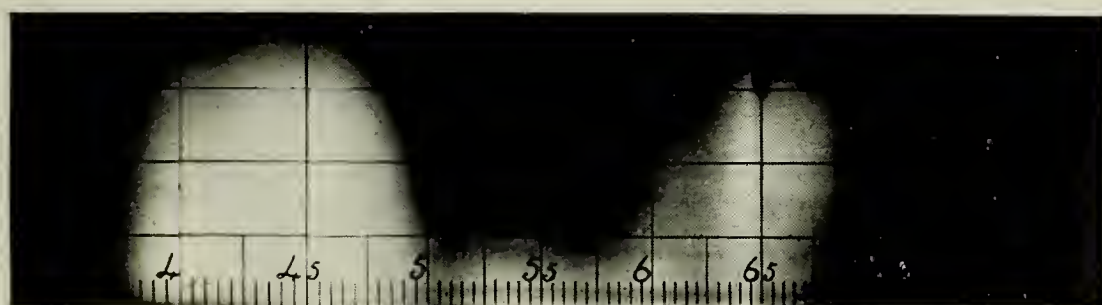


Fig. 75. Pinatype Amaranth 1/1,000.

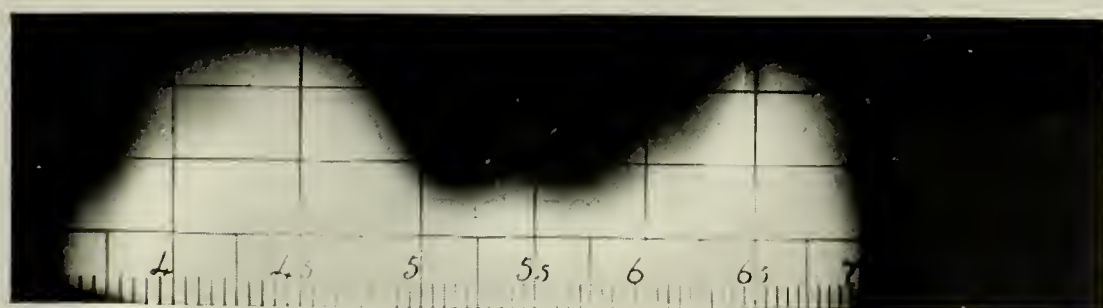


Fig. 76. Pinatype Violet 1/2,000.

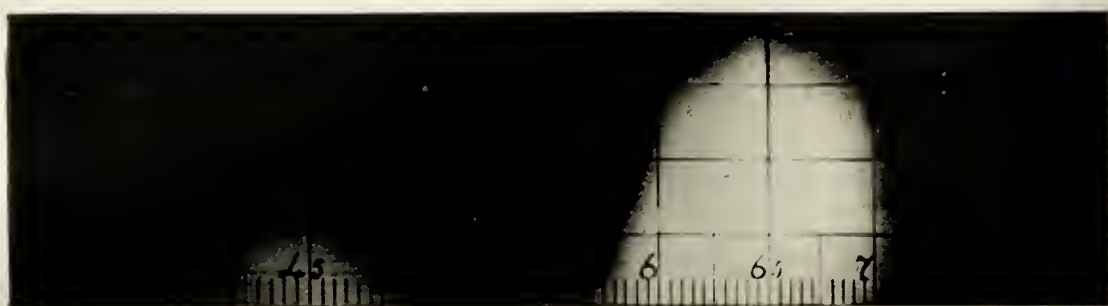


Fig. 77. Pinatype Carmine 1/2,000.



Fig. 78. Pinatype Carmine 1/500.



Fig. 79. Rapid Filter Blue 1/5,000.

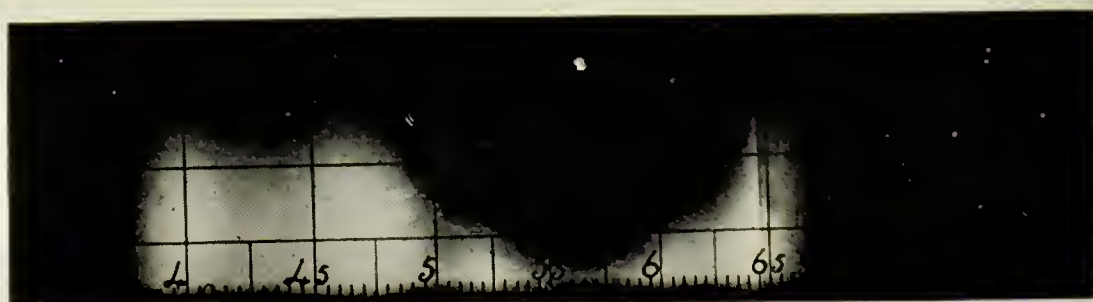


Fig. 80. Rapid Filter Blue 1/1,000.

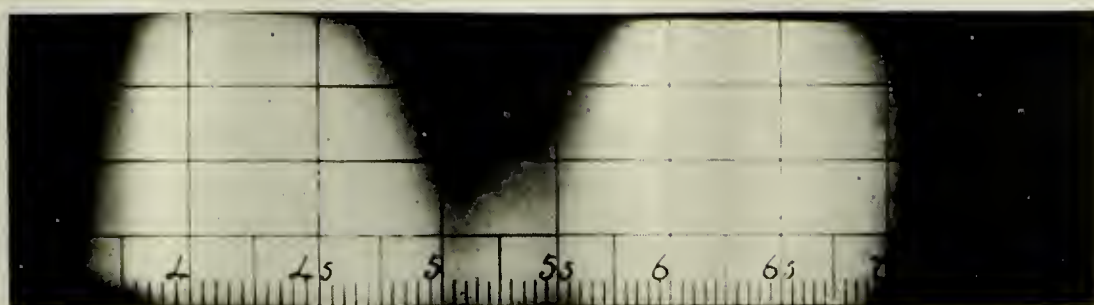


Fig. 81. Rosinduline 2 B. Bluish $1/2,500$.

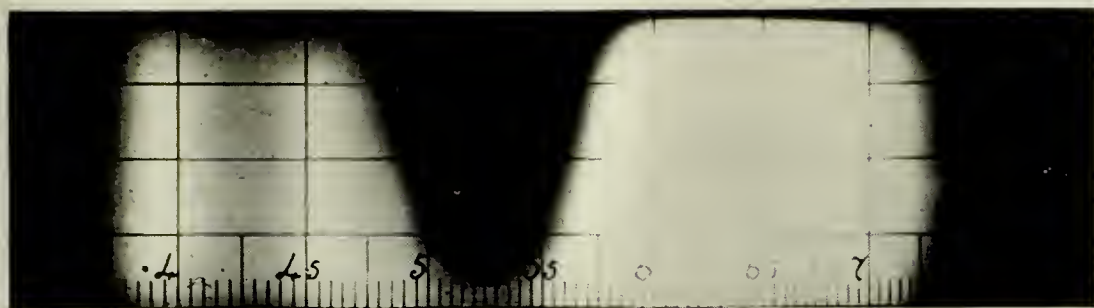


Fig. 82. Acid Violet 4 R. $1/2,500$.

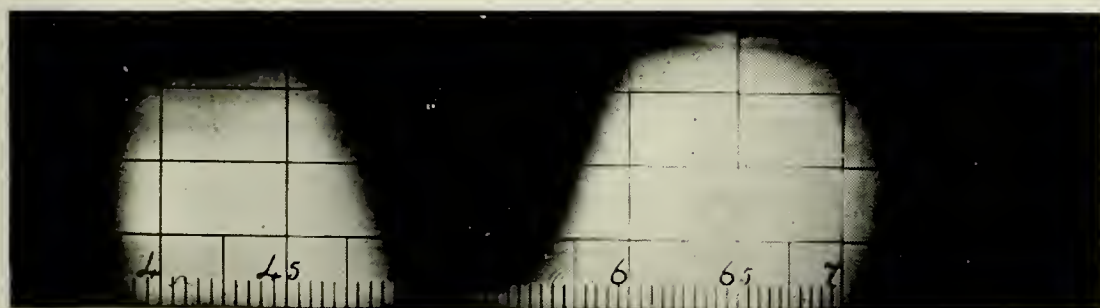


Fig. 83. Acid Violet 4 R. $1/2,000$.

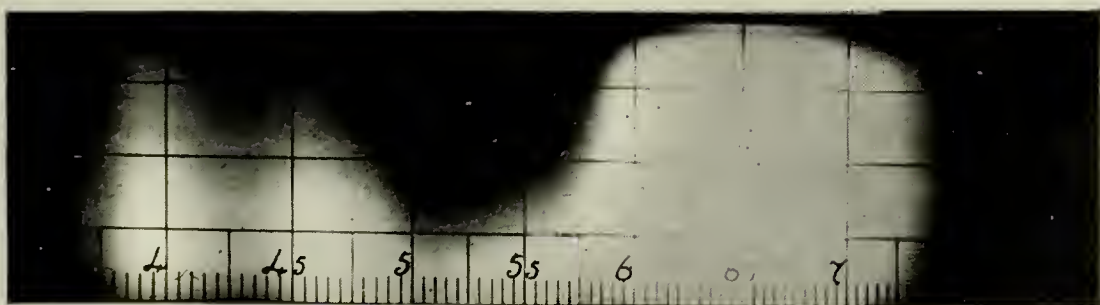


Fig. 84. Chromotrope F. 4 B $1/2,000$.

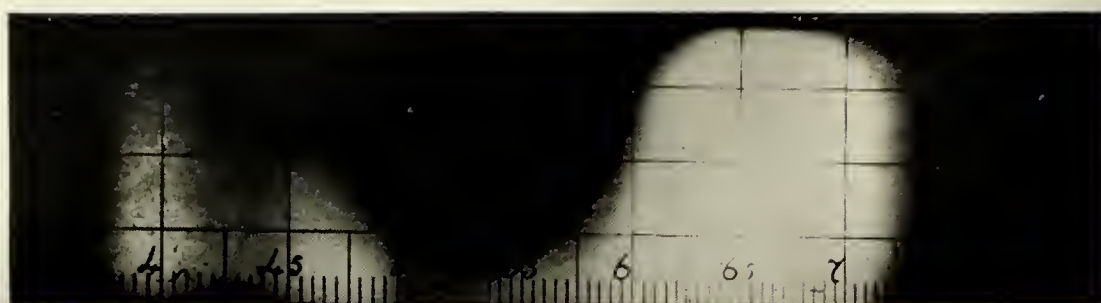


Fig. 85. Chromotrope 10 B. $1/2,500$.

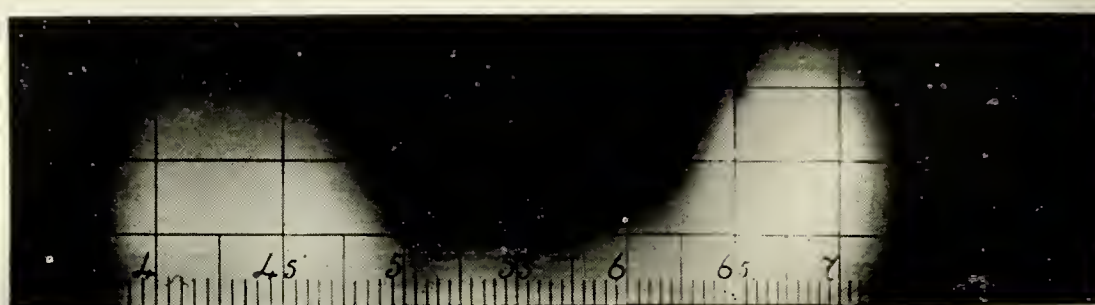


Fig. 86. Acid Chrome Blue 2 R. $1/2,500$.

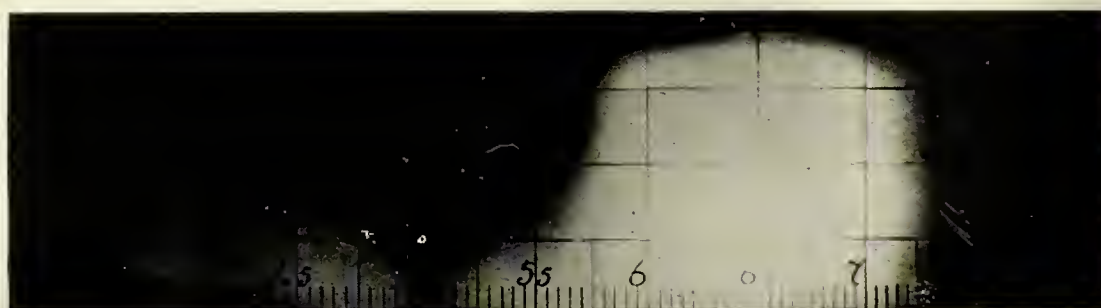


Fig. 87. Acid Chrome Blue $1/2,500$.

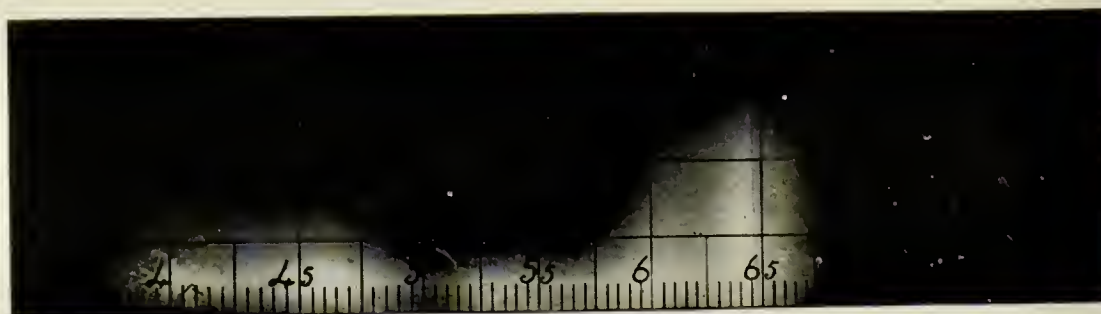


Fig. 88. Echt Beizenblau $1/2,000$.

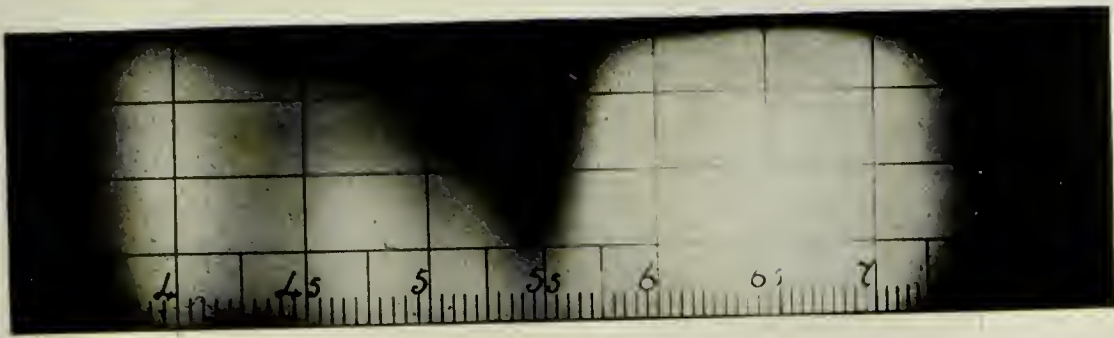


Fig. 89. Fuchsin $1/2,500$.

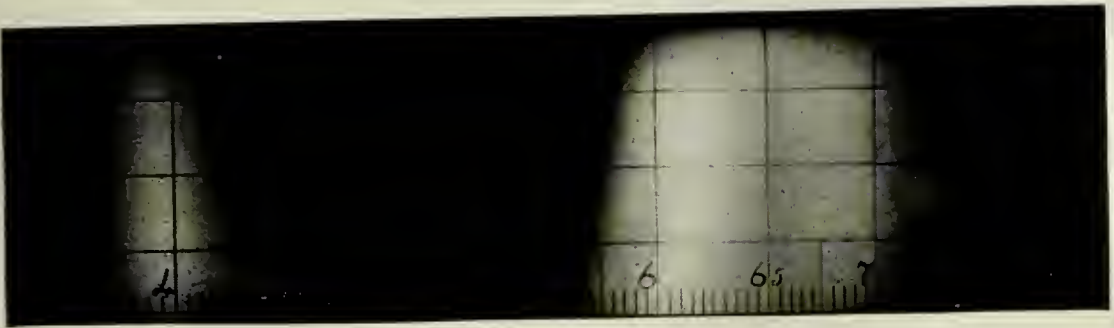


Fig. 90. Rubine Fuchsin $1/2,500$.

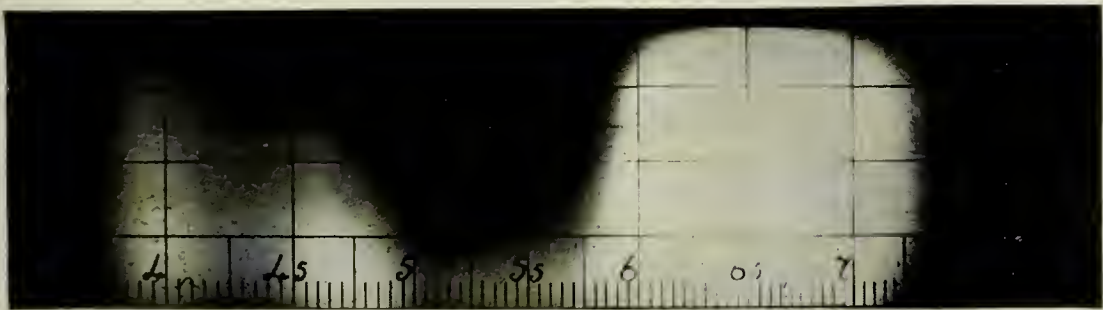


Fig. 91. Methyl Violet B. B. R. $1/2,500$.

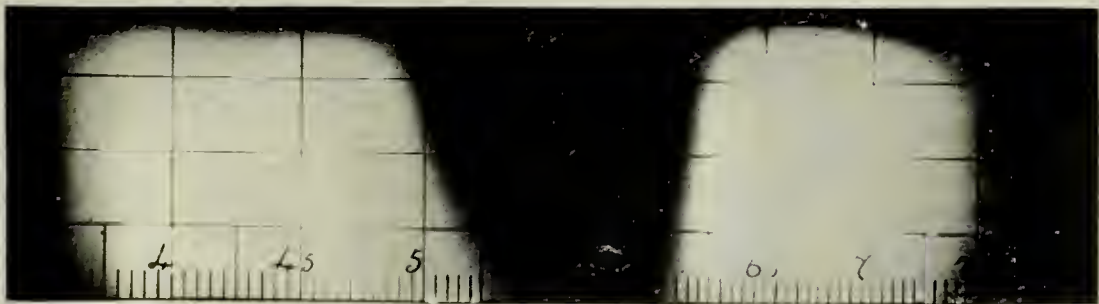


Fig. 92. Methyl Violet 6 B. $1/2,500$.

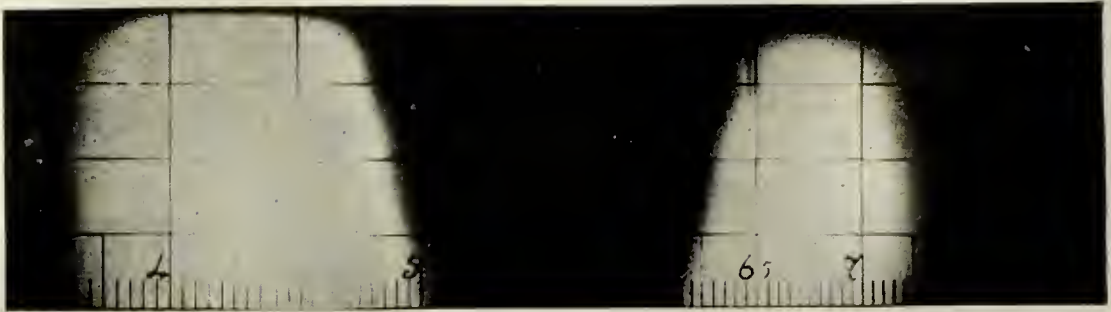


Fig. 93. Methyl Violet 1 B. 1/16,000.

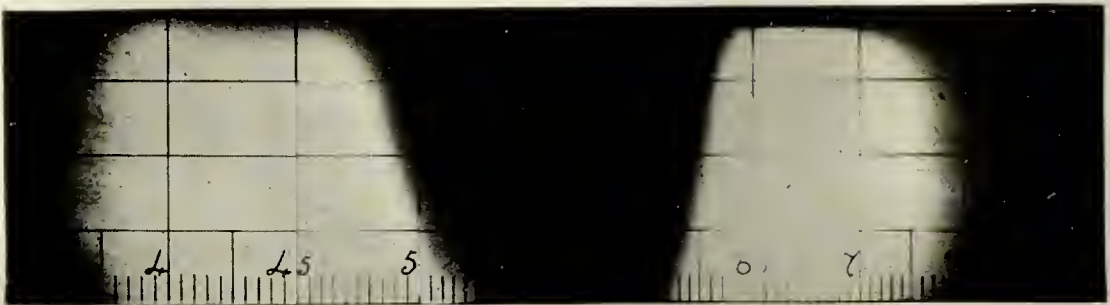


Fig. 94. Crystal Violet 1/10,000.

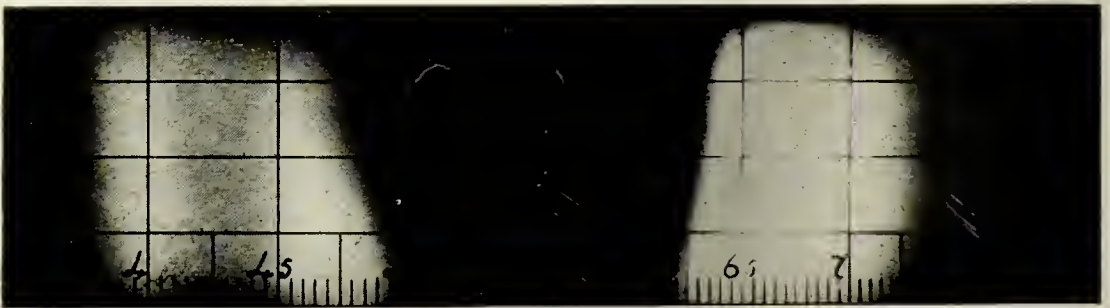


Fig. 95. Crystal Violet 1/5,000.



Fig. 96. Gentian Violet 1/2,000.

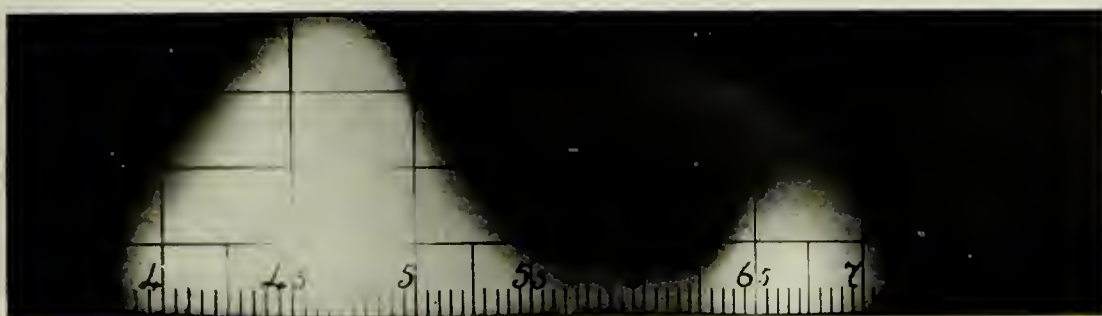


Fig. 97. Acid Violet B. N. 1/300.

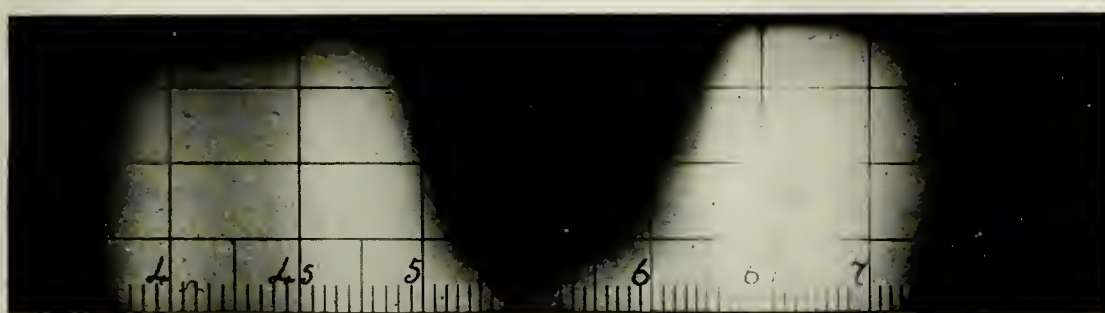


Fig. 98. Acid Violet 4 B.C. 1/2,500.



Fig. 99. Acid Violet 4 B.C. 1/500.

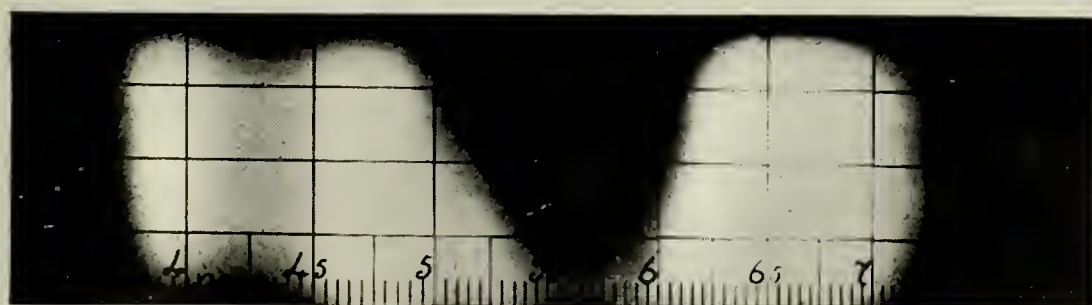


Fig. 100. Rhoduline Blue R. 1/2,500.

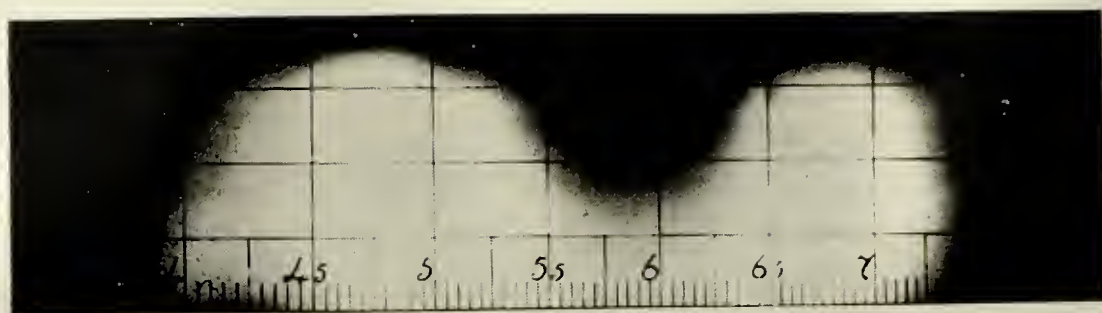


Fig. 101. Aniline Blue $1/2,500$.

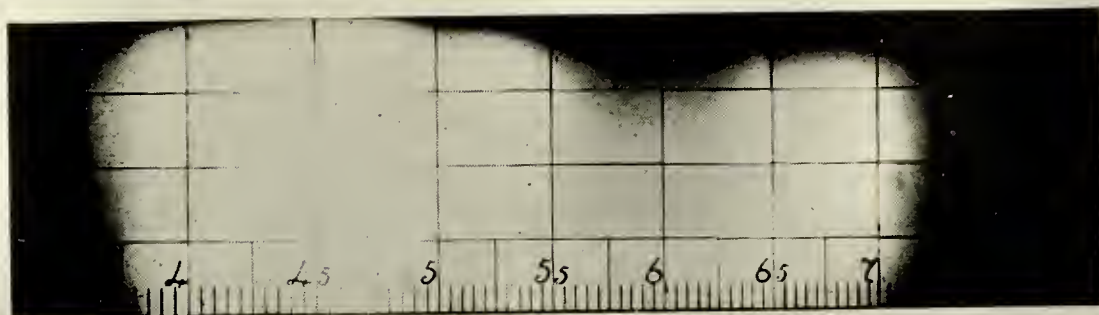


Fig. 102. Alkali Blue $1/5000$.

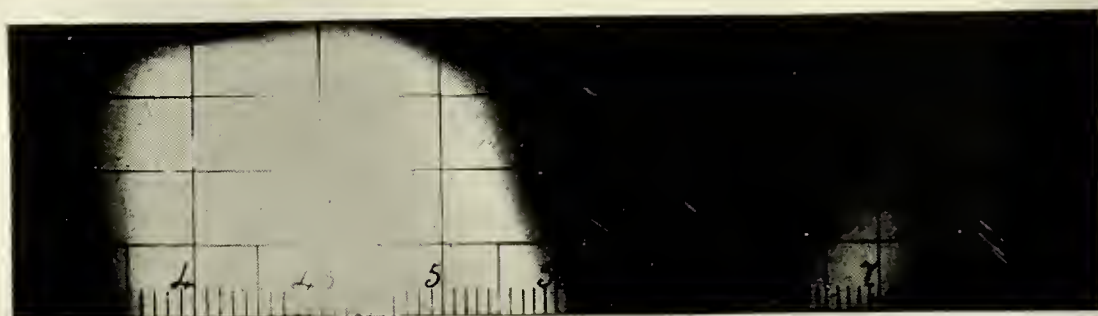


Fig. 103. Alkali Blue $1/1,000$.

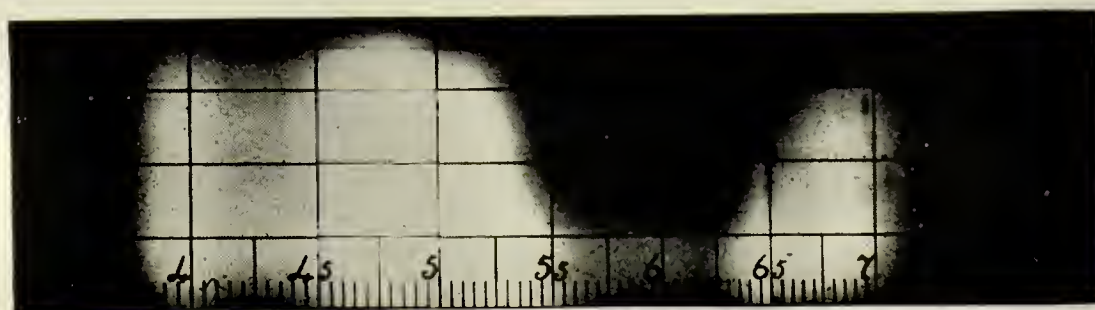


Fig. 104. Victoria Pure Blue B. $1/10,000$.

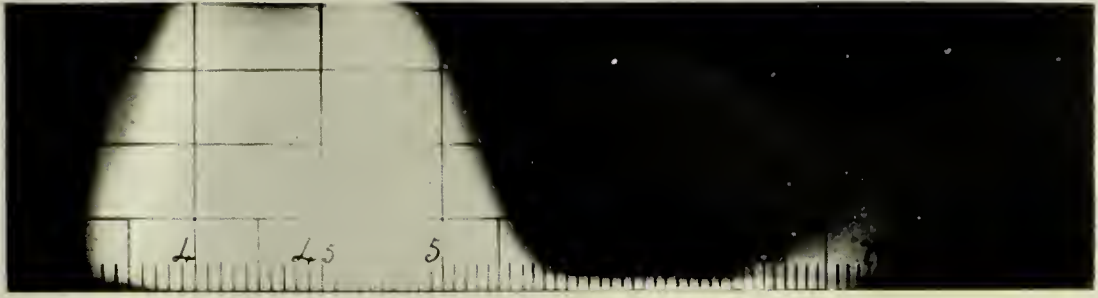


Fig. 105. Victoria Pure Blue B. $1/2,000$.

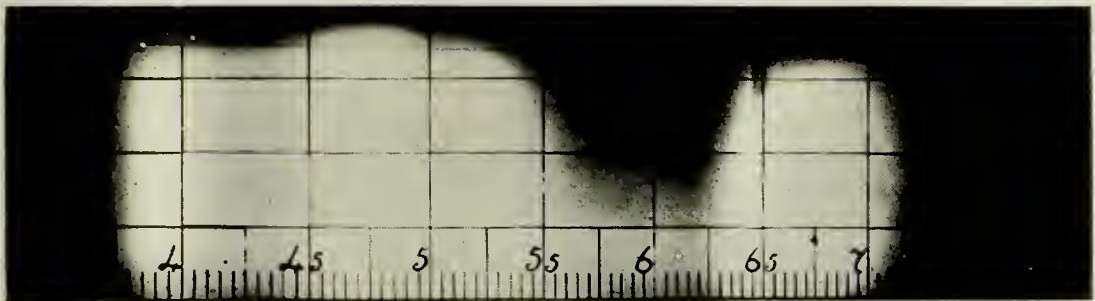


Fig. 106. Victoria Blue B. $1/10,000$.

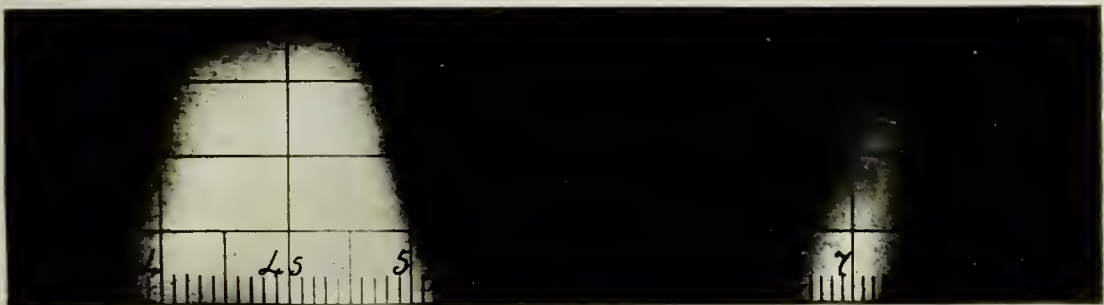


Fig. 107. Victoria Blue B. $1/2,500$.

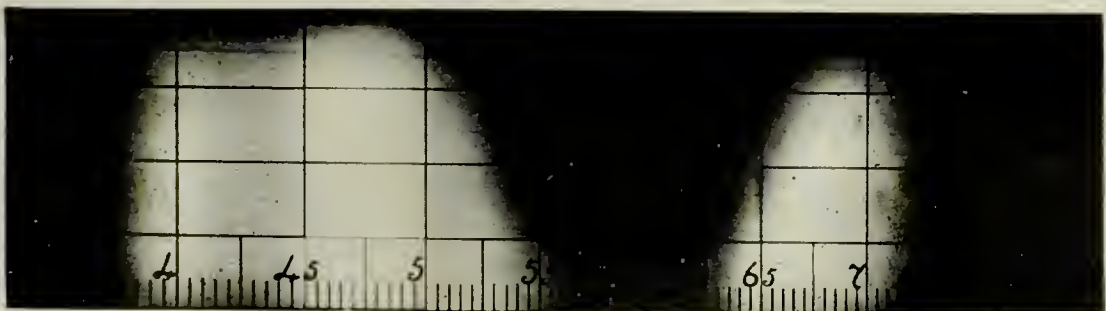


Fig. 108. Victoria Blue B. S. $1/10,000$.

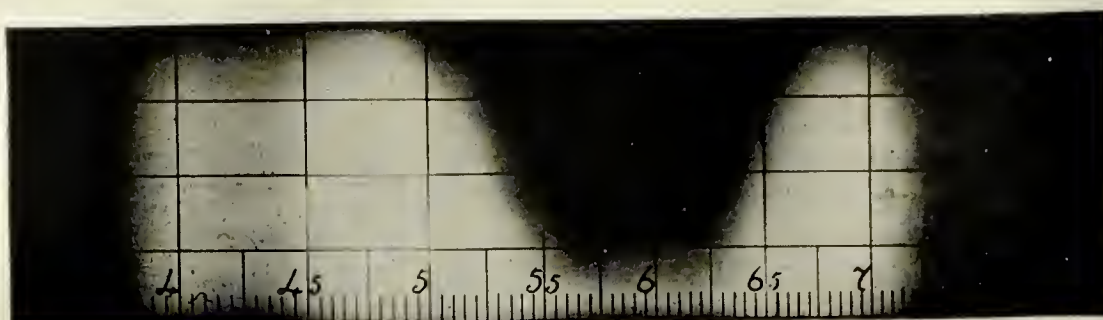


Fig. 109. Victoria Blue B. S. S. 1/10,000.

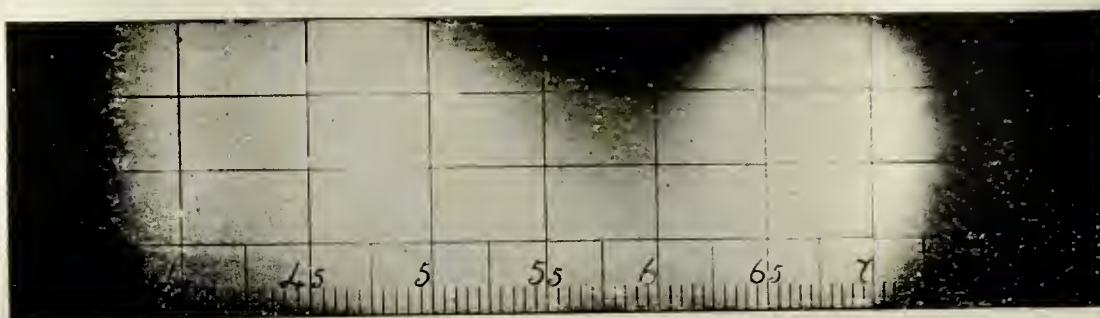


Fig. 110. Victoria Blue 4 R. 1/10,000.

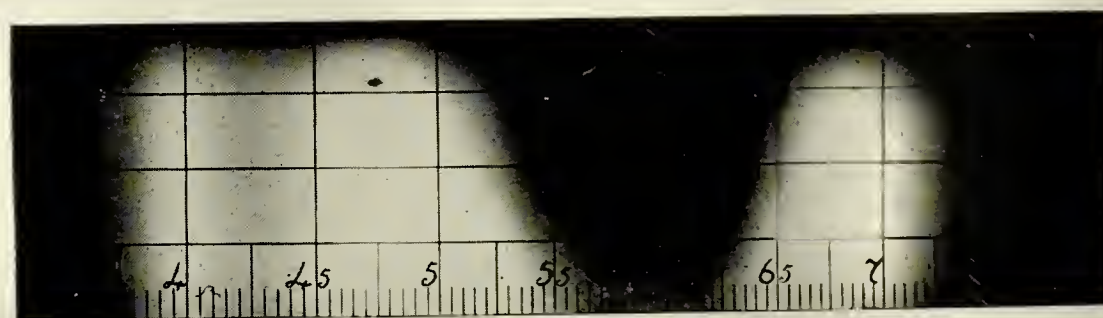


Fig. 111. Victoria Blue 4 R. 1/5,000.

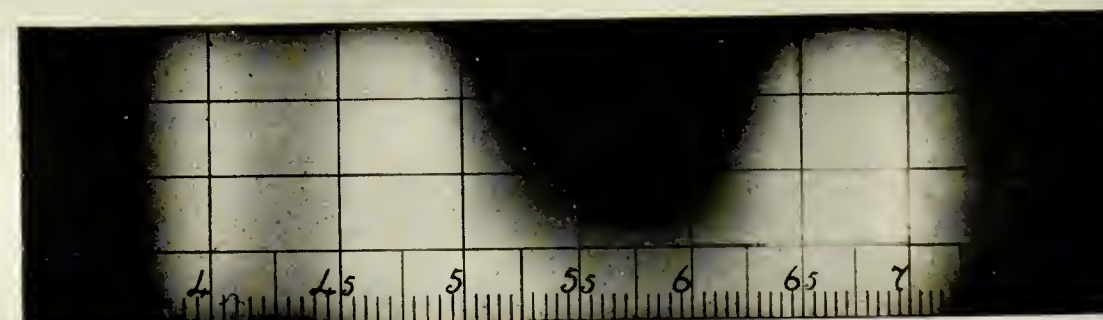


Fig. 112. Victoria Blue R. 1/10,000.

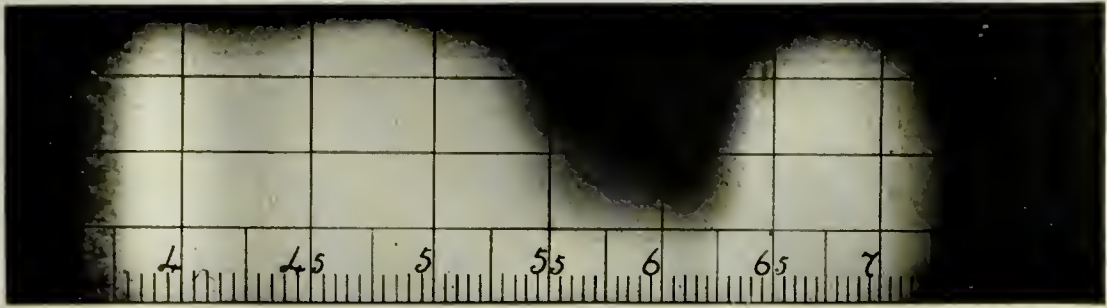


Fig. 113 Victoria Blue R. $1/5,000$.

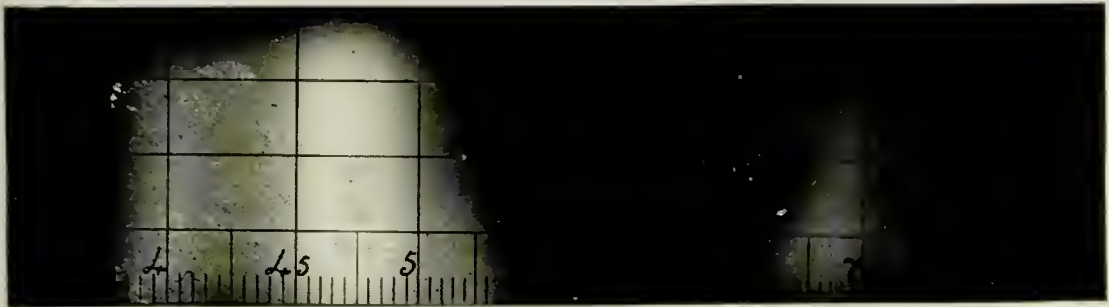


Fig. 114. Night Blue $1/5,000$.



Fig. 115. Night Blue $1/2,000$.

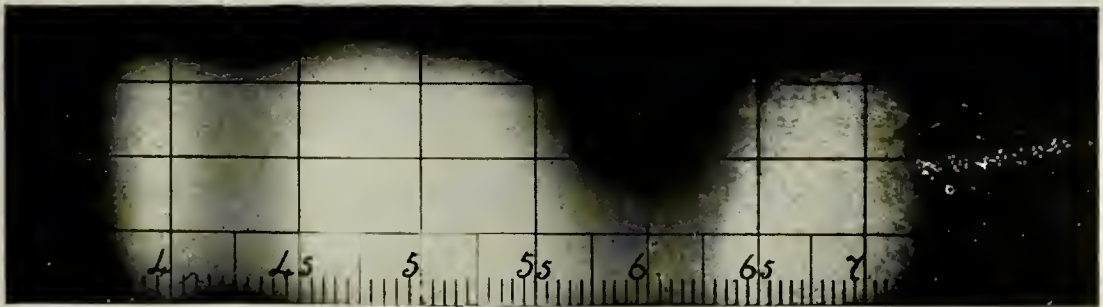


Fig. 116. Pinatype Blue $1/5,000$.

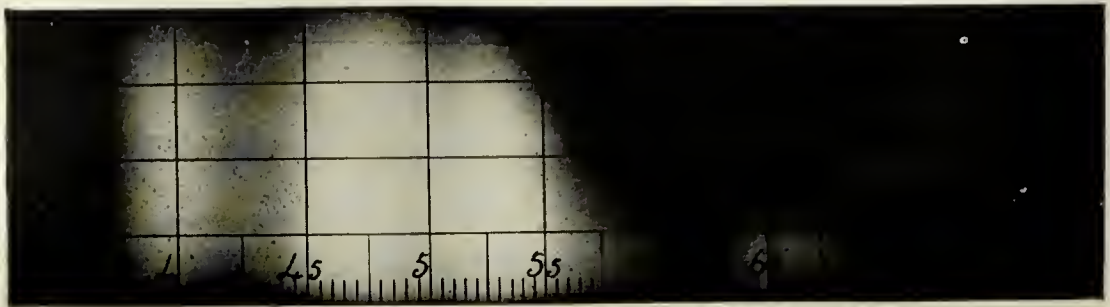


Fig. 117. Toluidine Blue 1/5,000.

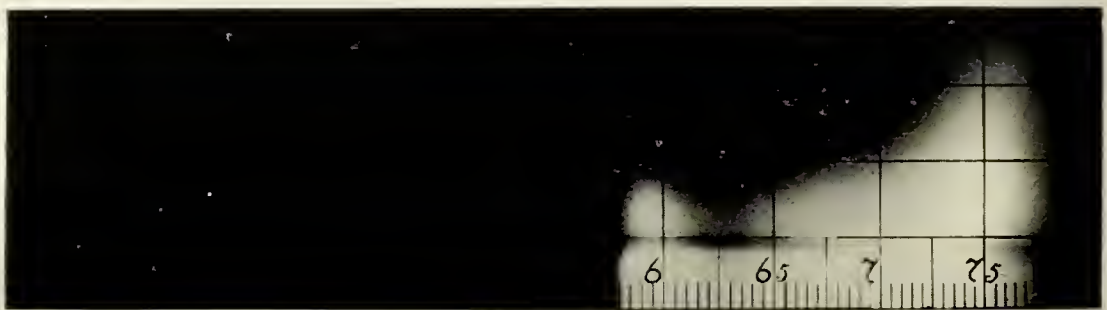


Fig. 118. Toluidine Blue 1/10,000. (Red end only).



Fig. 119. Toluidine Blue 1/1,000 (Red end only).

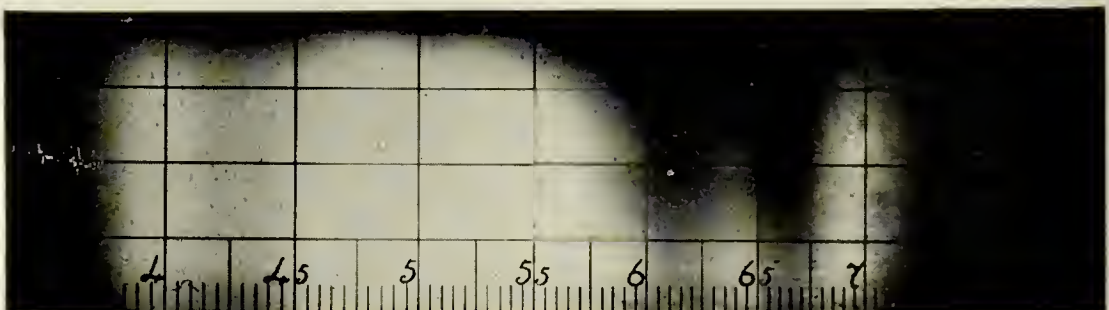


Fig. 120. Methylene Blue 1/10,000.

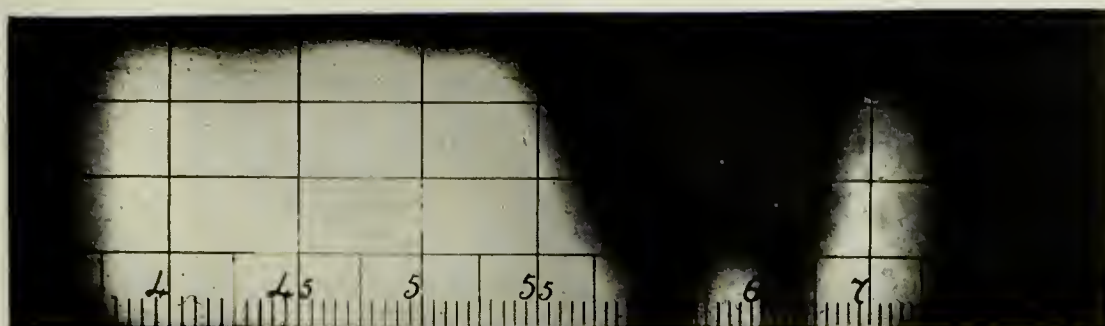


Fig. 121. Methylene Blue 1/5,000.

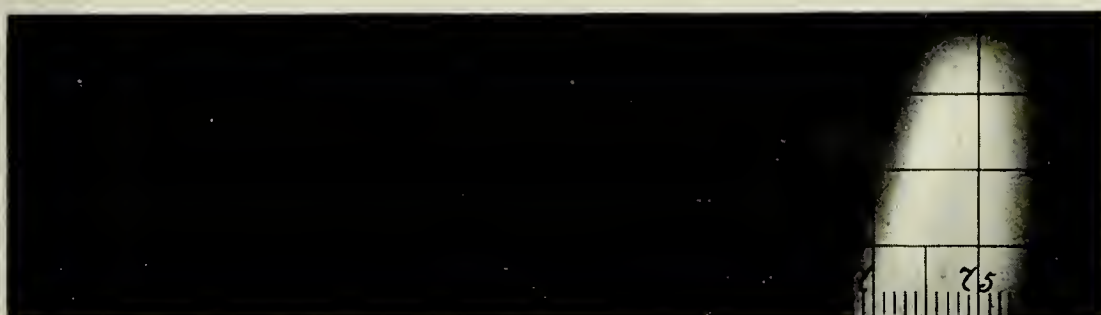


Fig. 122. Methylene Blue 1/5,000 (Red end only).

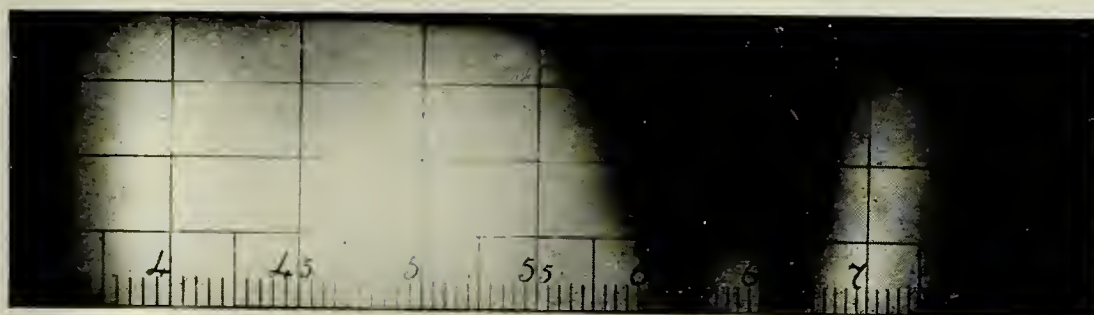


Fig. 123. Thionine Blue 1/10,000.

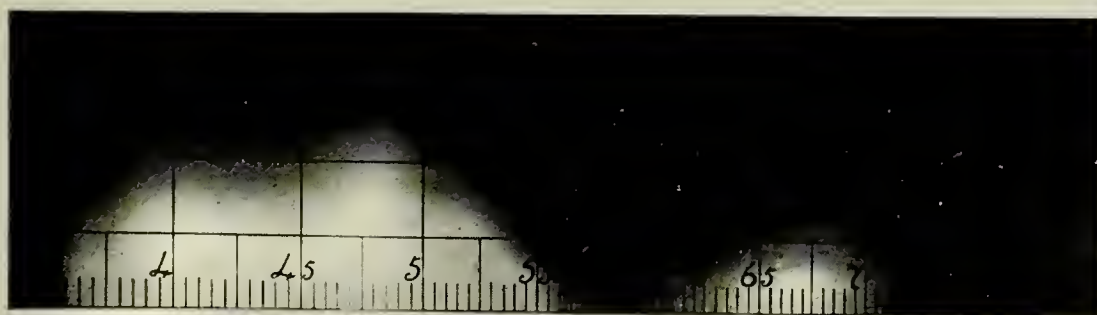


Fig. 124. Janus Green 1/1,000.

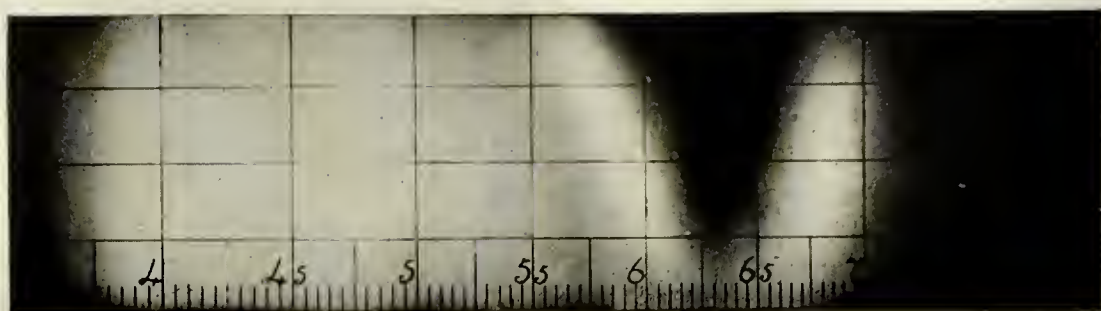


Fig. 125. Patent Blue A. $1/10,000$.

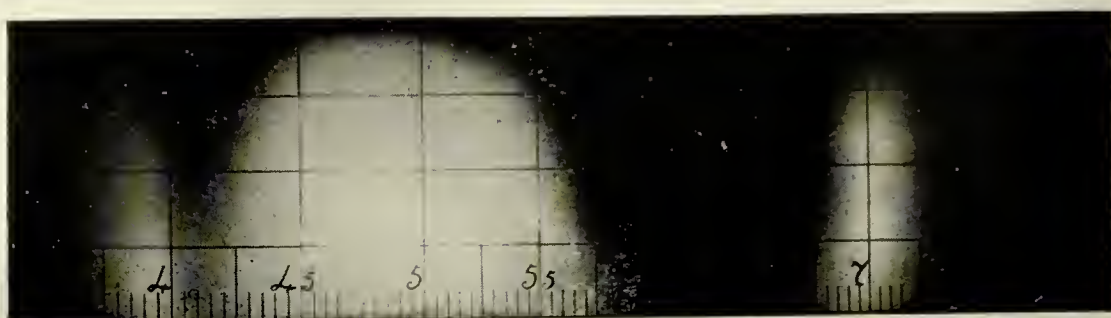


Fig. 126. Patent Blue A. $1/2,500$.

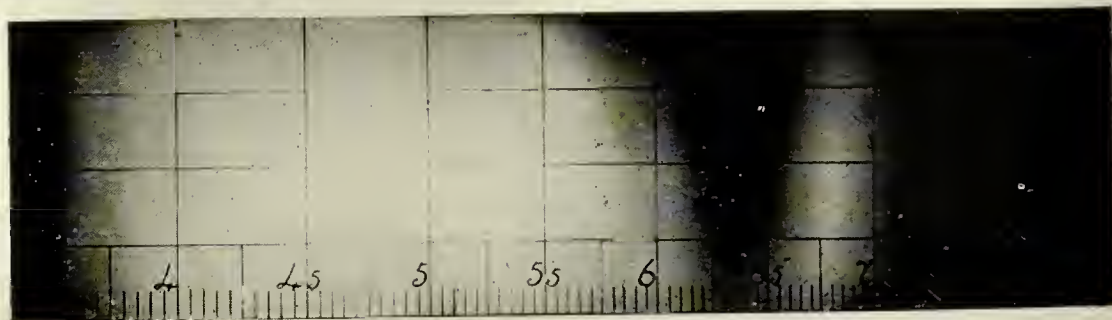


Fig. 127. Patent Blue V. $1/10,000$.

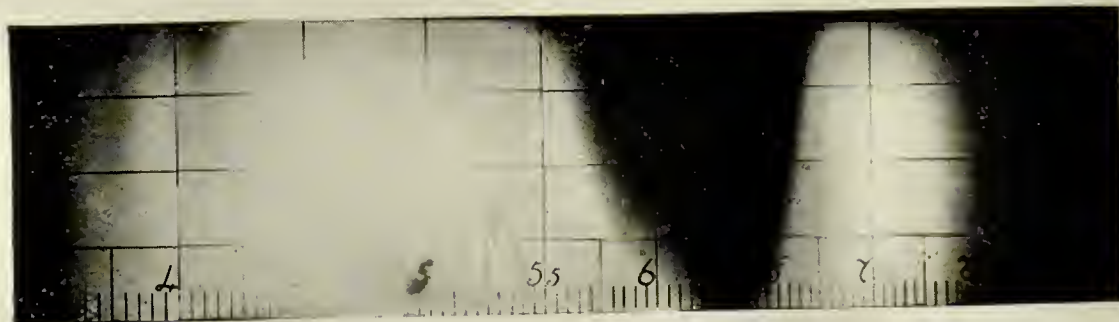


Fig. 128. Patent Blue V. $1/5,000$.

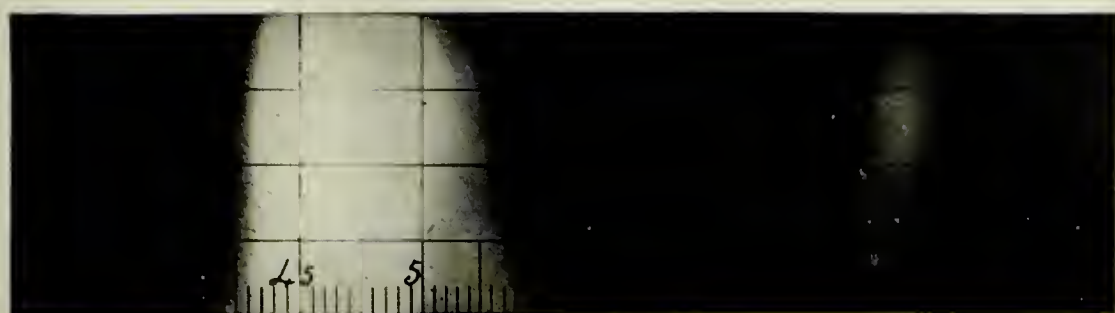


Fig. 129. Patent Blue V. 1/1,000.

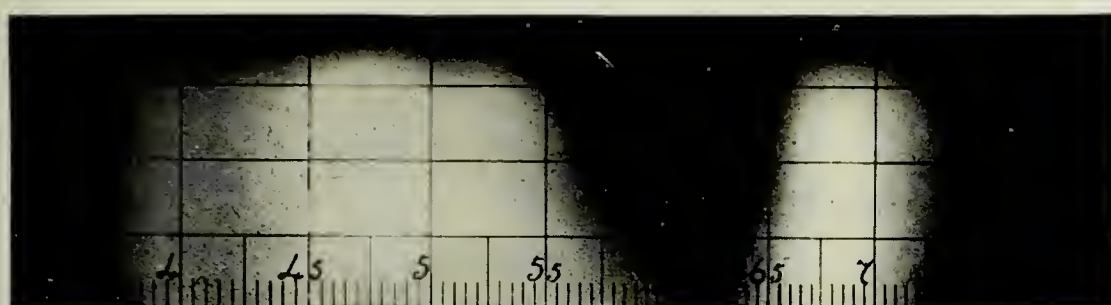


Fig. 130. Cyanine Blue 1/10,000.

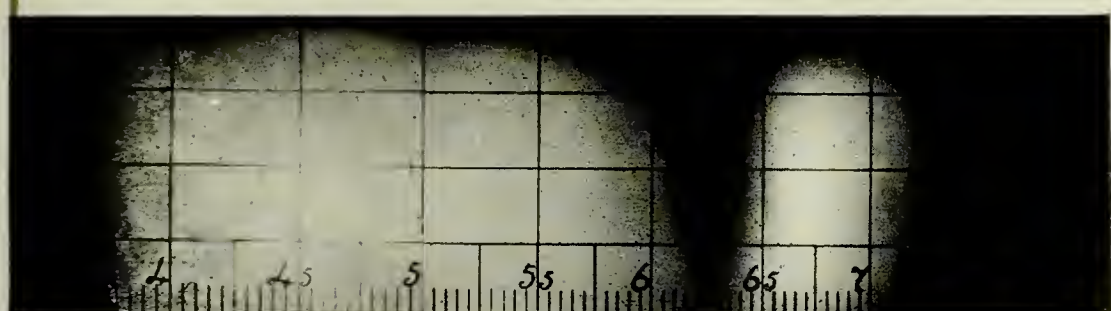


Fig. 131. Erioglaucine A. 1/10,000.

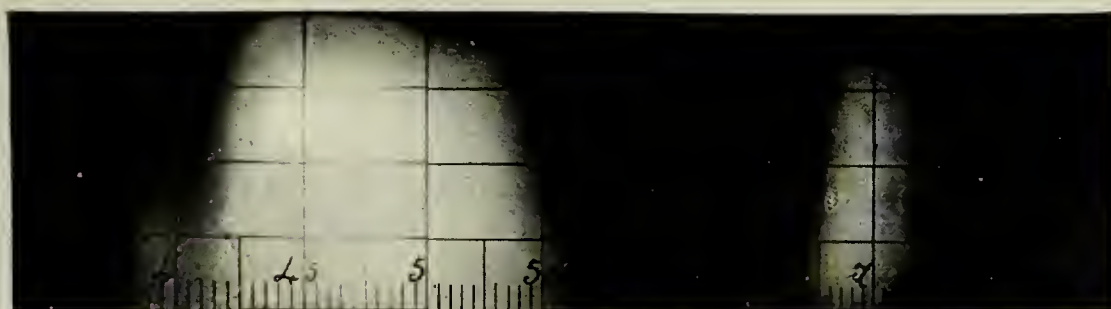


Fig. 132. Erioglaucine A. 1/1,000.

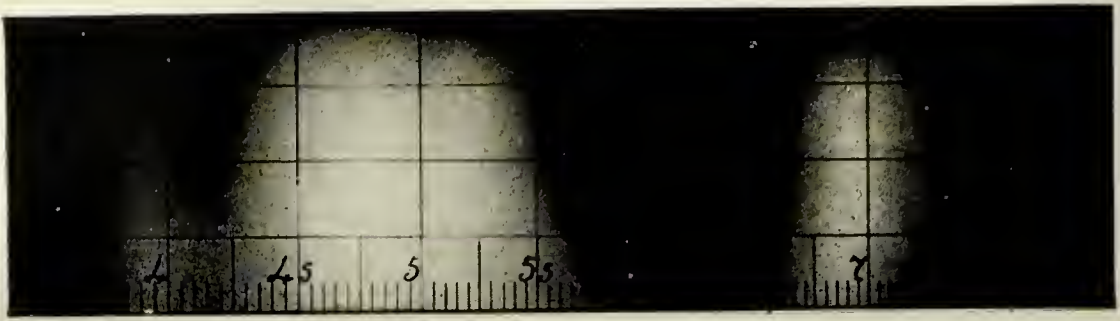


Fig. 133. Setoglaucine 1/5,000.

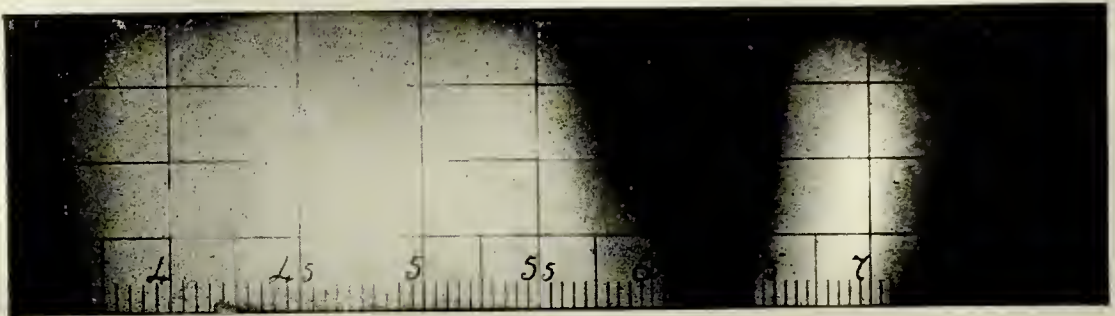


Fig. 134. Turkish Blue B. B. 1/10,000.

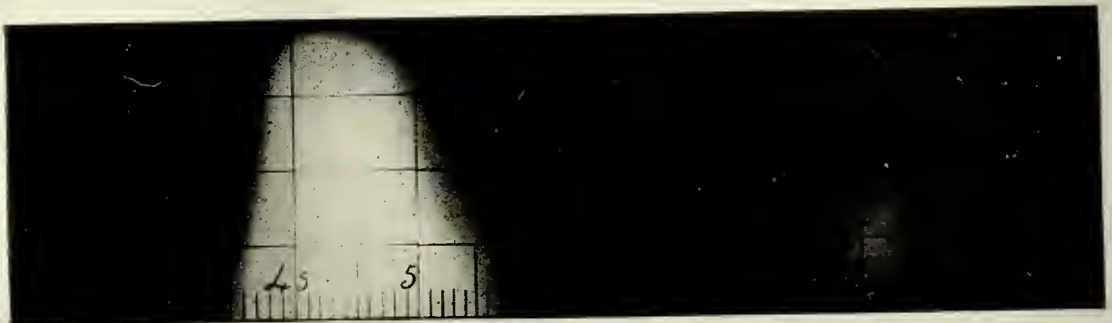


Fig. 135. Turkish Blue B. B. 1/1,000.

V.G.

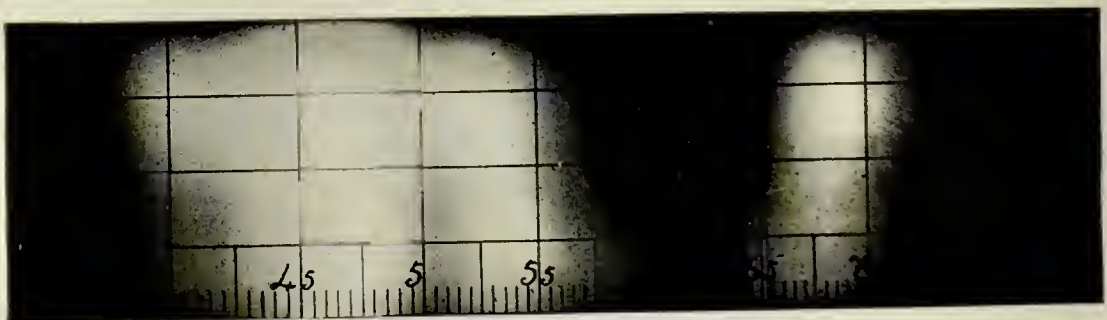


Fig. 136. Methylene Green 1/5,000.

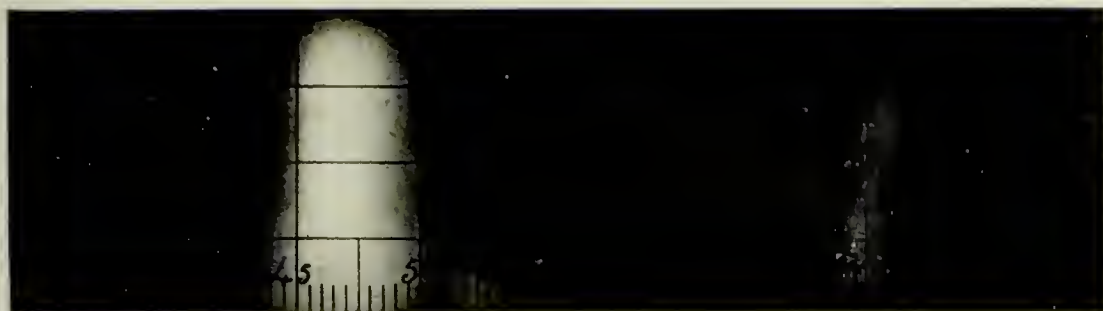


Fig. 137. Methylene Green 1/1,000.

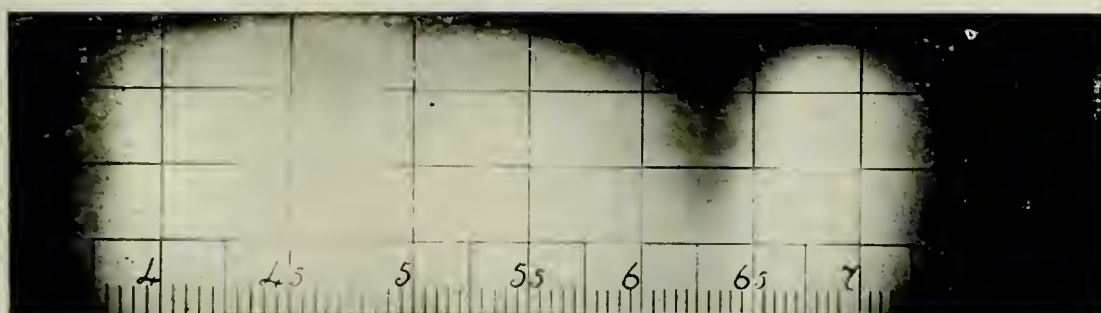


Fig. 138. Iodine Green 1/10,000.

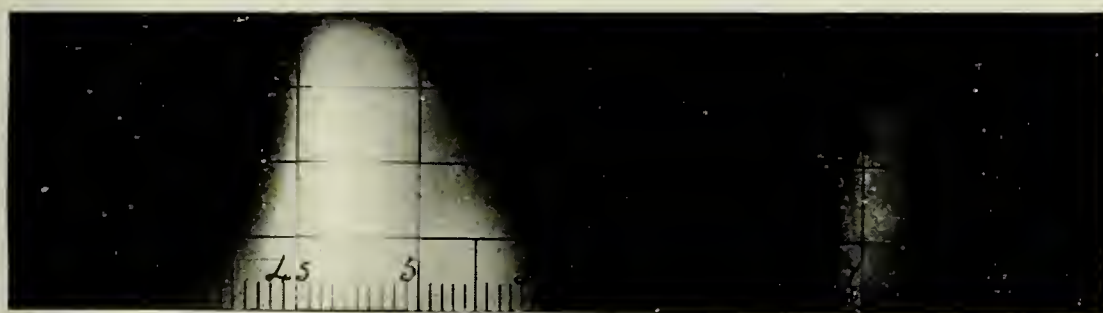


Fig. 139. Iodine Green 1/1,000.

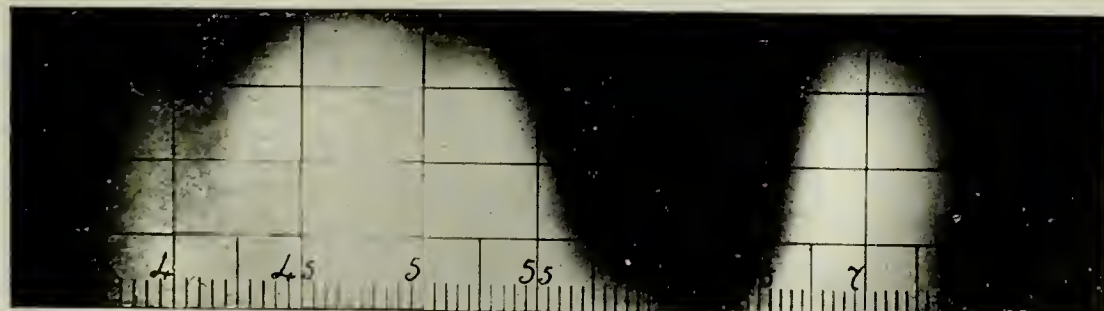


Fig. 140. Fast Green Blue Shade 1/1,000.

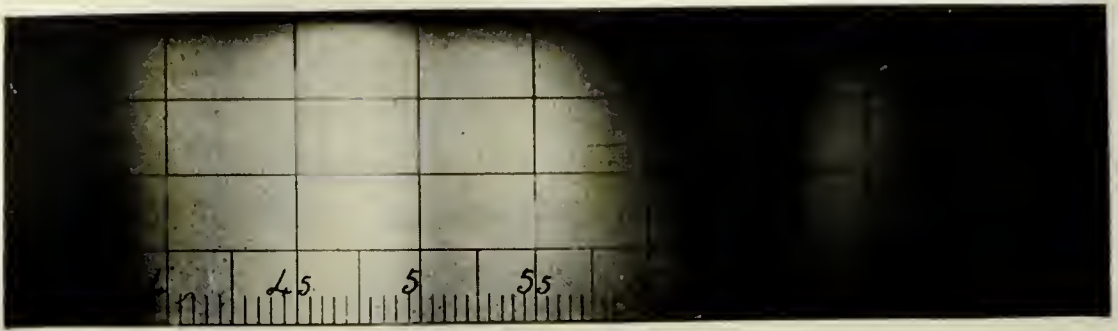


Fig. 141. Complementary Green 1. $1/10,000$.

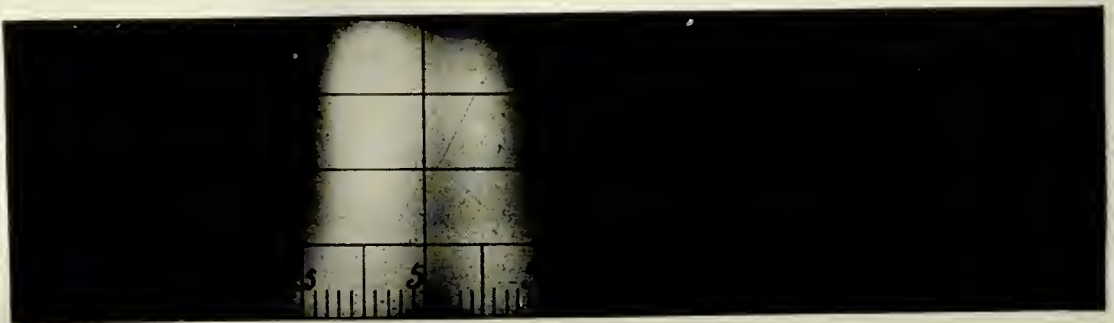


Fig. 142. Complementary Green 1. $1/1,000$.

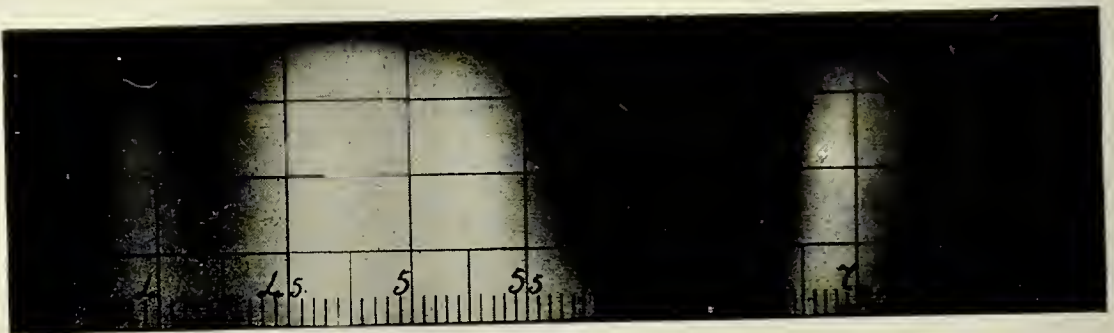


Fig. 143. Solid Green $1/1,000$.

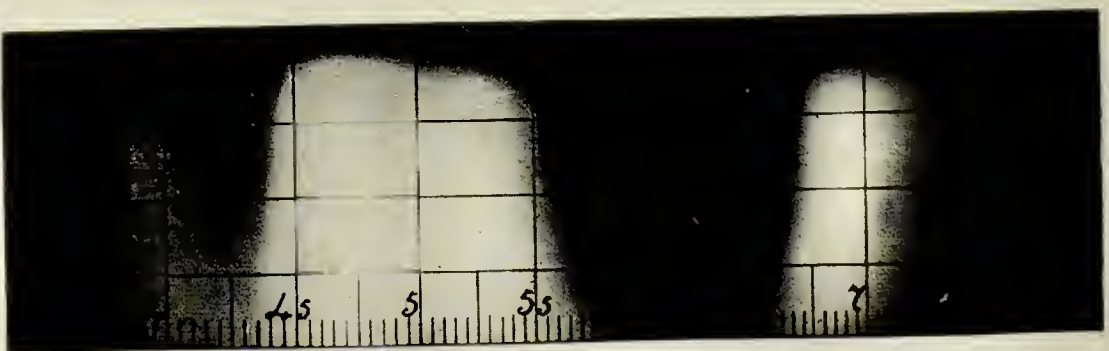


Fig. 144. New Solid Green $1/10,000$.

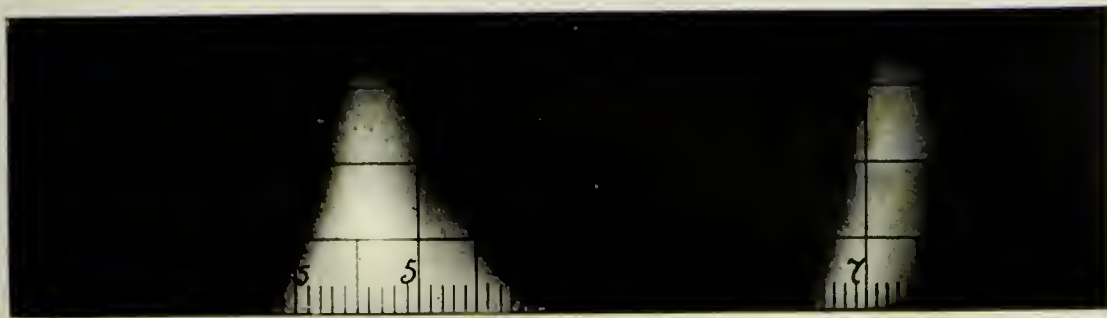


Fig. 145. New Solid Green 1/1,000.

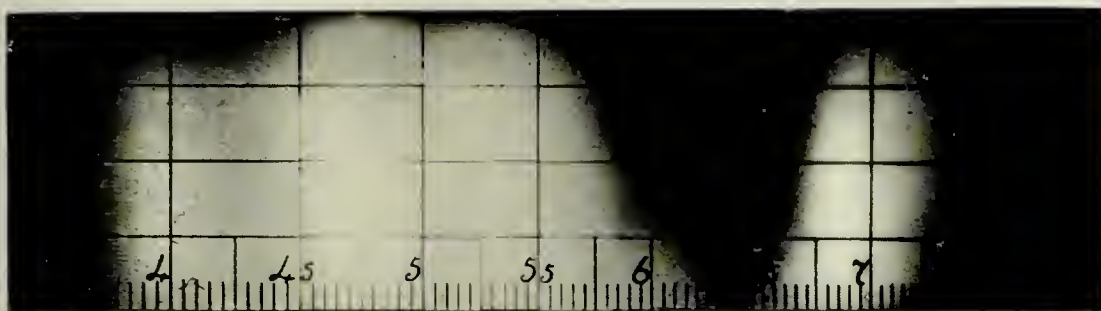


Fig. 146. Naphthaline Green 1/10,000.

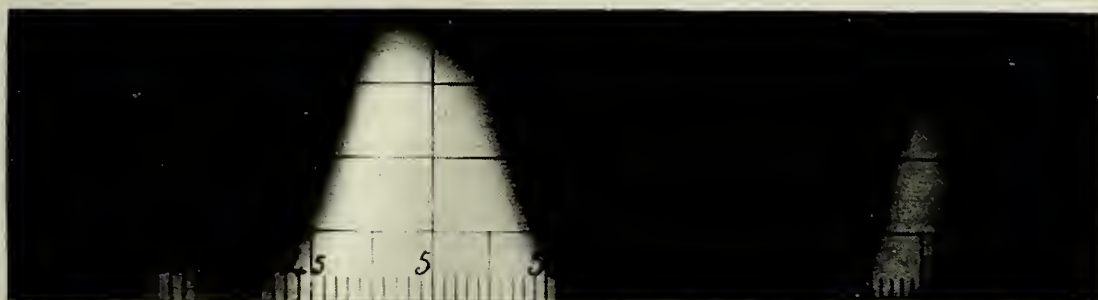


Fig. 147. Naphthaline Green 1/1,000.

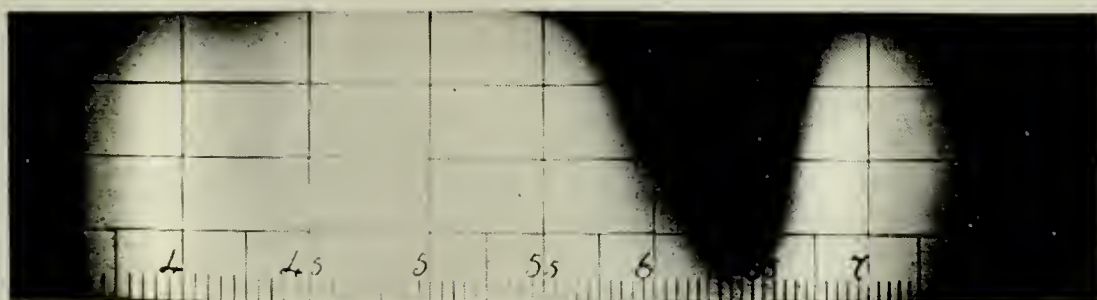


Fig. 148. Rapid Filter Green 1/10,000.

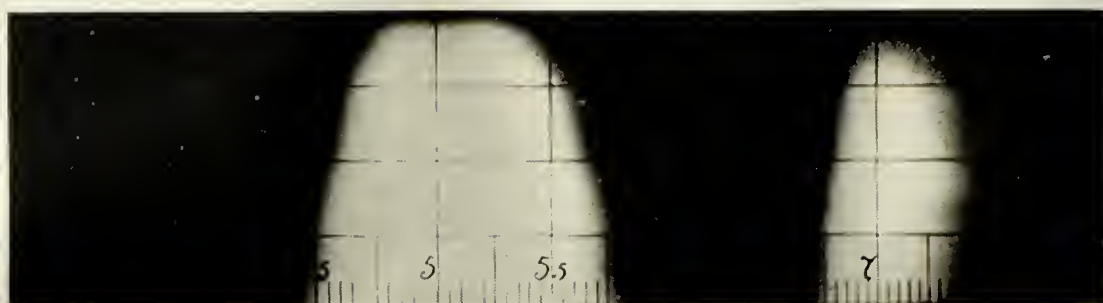


Fig. 149. Rapid Filter Green 1/1,000.

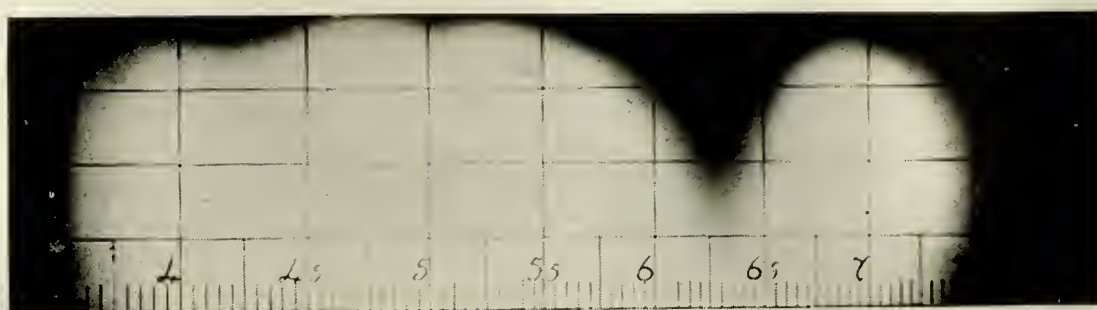


Fig. 150. Acid Green 1/5,000.

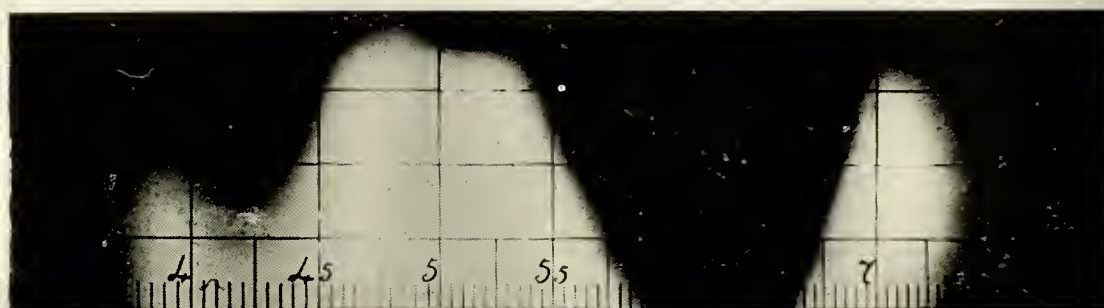


Fig. 151. Acid Green 1/1,000.

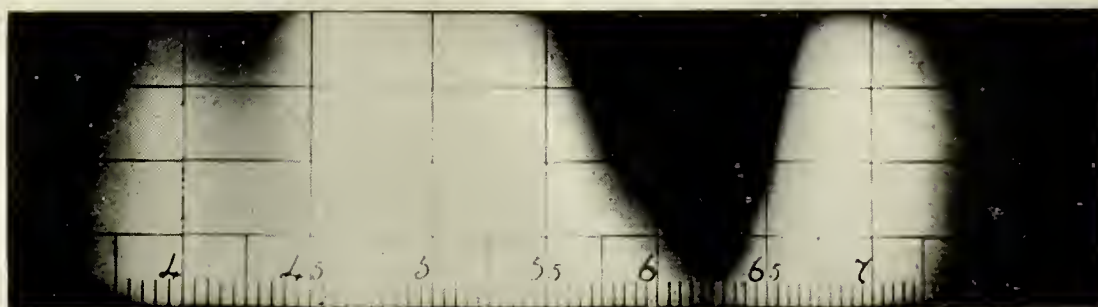


Fig. 152. Emerald Green 1/1,000.

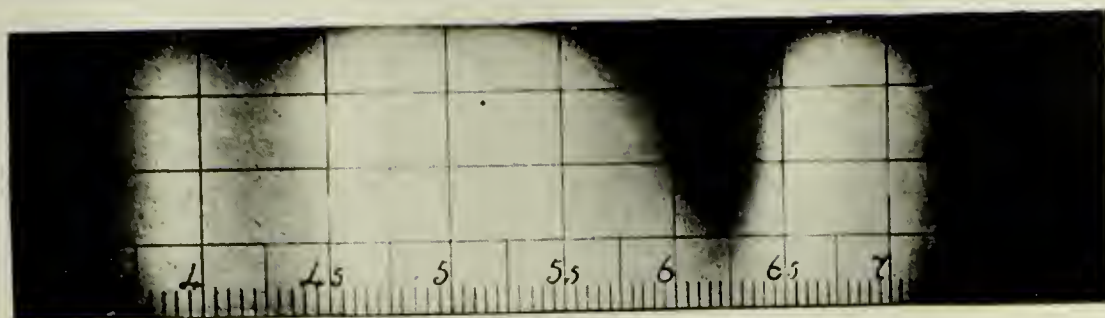


Fig. 153. Brilliant Green $1/5,000$.

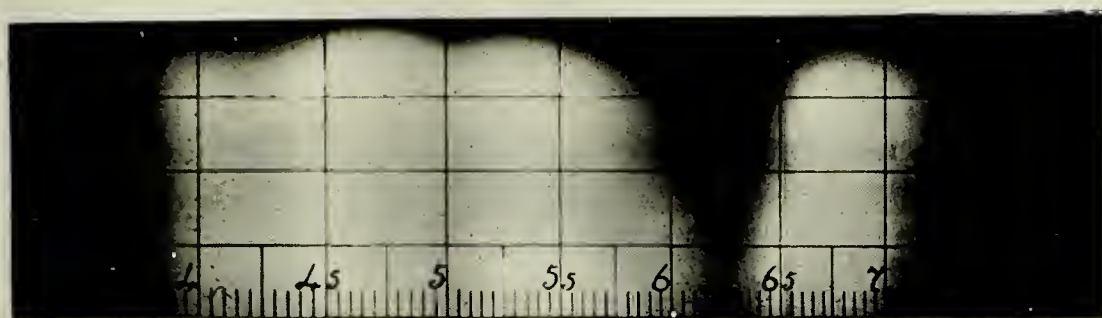


Fig. 154. Diamond Green $1/10,000$.

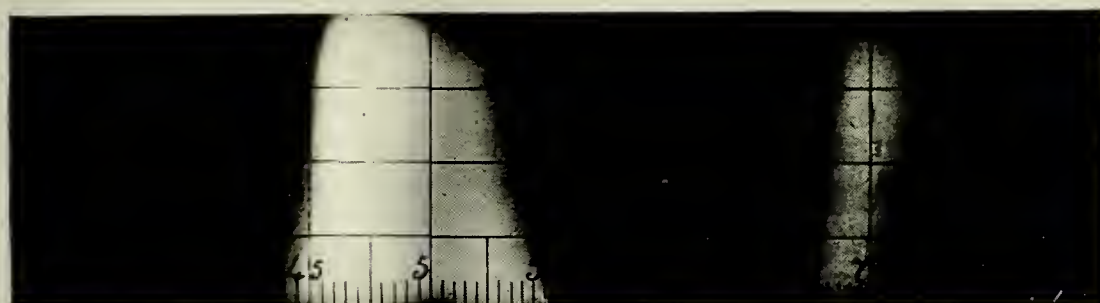


Fig. 155. Diamond Green $1/1,000$.

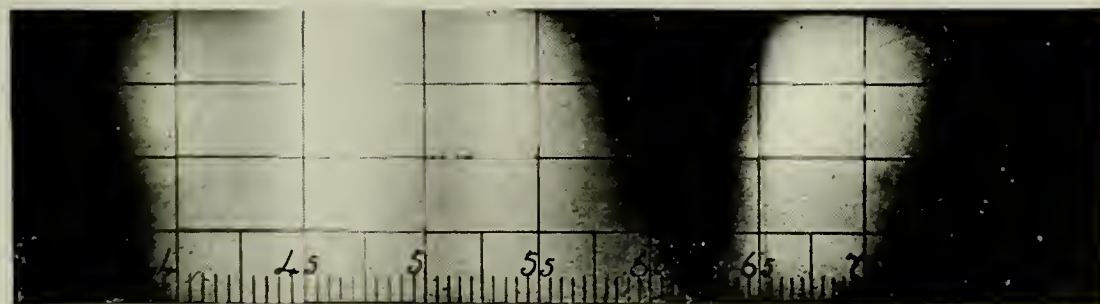


Fig. 156. Victoria Green 1. $1/10,000$.



Fig. 157. Victoria Green 1. 1/1,000.

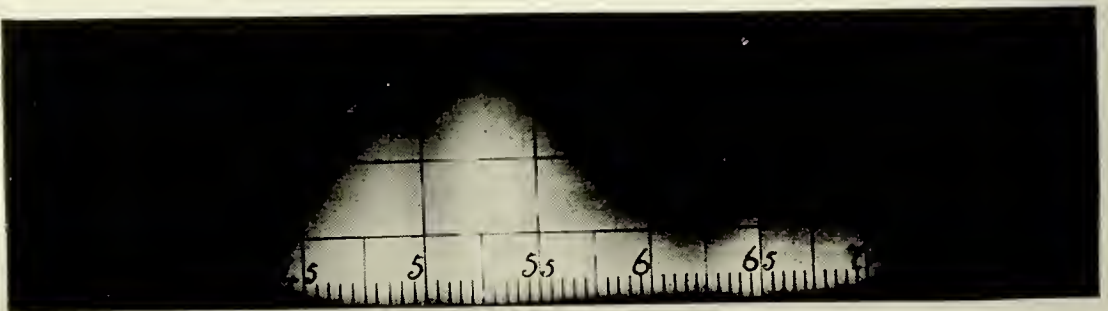


Fig. 158. Eboli Green 1/1,000.

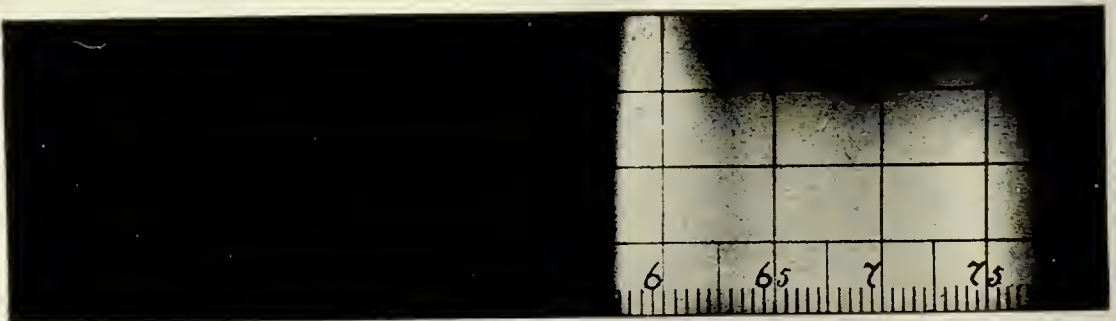


Fig. 159. Naphthol Green 1/5,000 (Red end only).



Fig. 160. Naphthol Green 1/1,000 (Red end only).

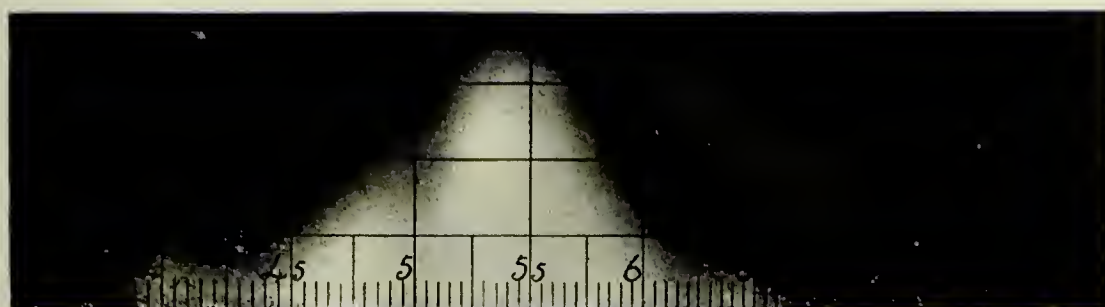


Fig. 161. Naphthol Green 1/1,000.



Fig. 162. Naphthol Green 2·6. 1/2,500 (Red end only).

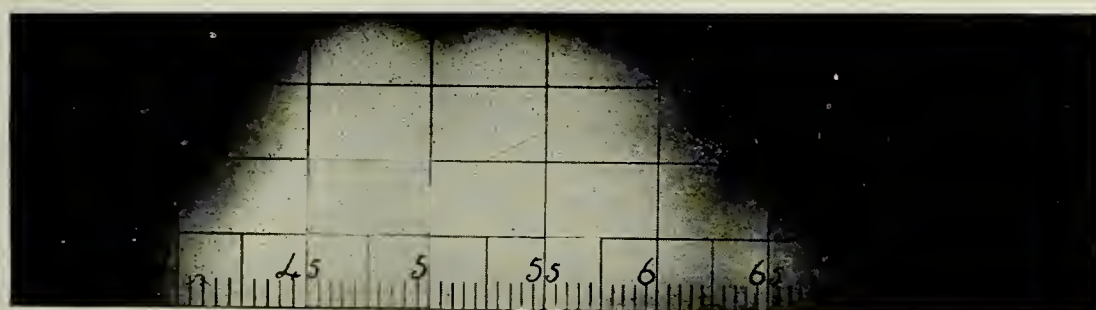


Fig. 163. Naphthol Green 2·6. 1/1,000.

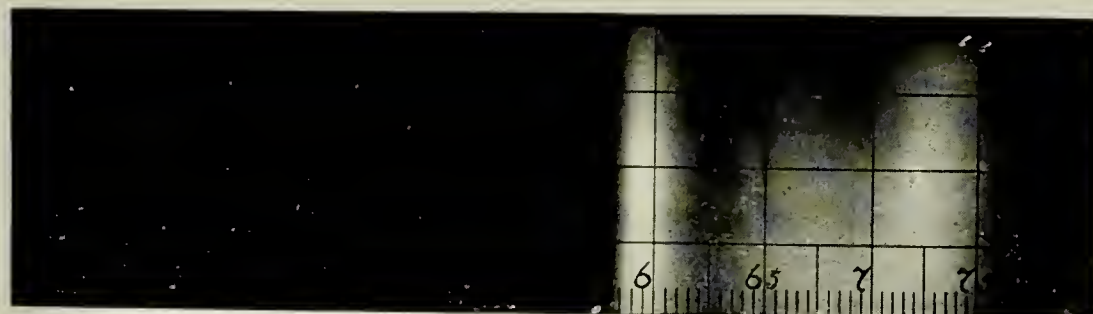


Fig. 164. Pinatype Green M. 1/5,000 (Red end only).

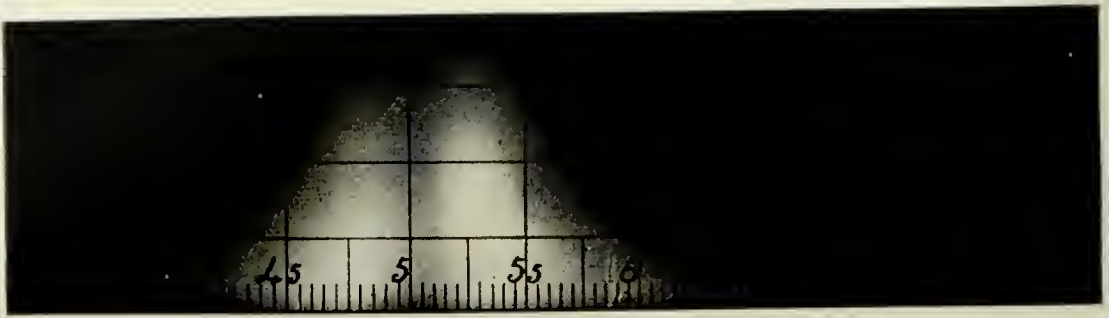


Fig. 165. Pinatype Green M. 1/1,000.



Fig. 166. Toluidine Green 1/2,000 (Red end only).

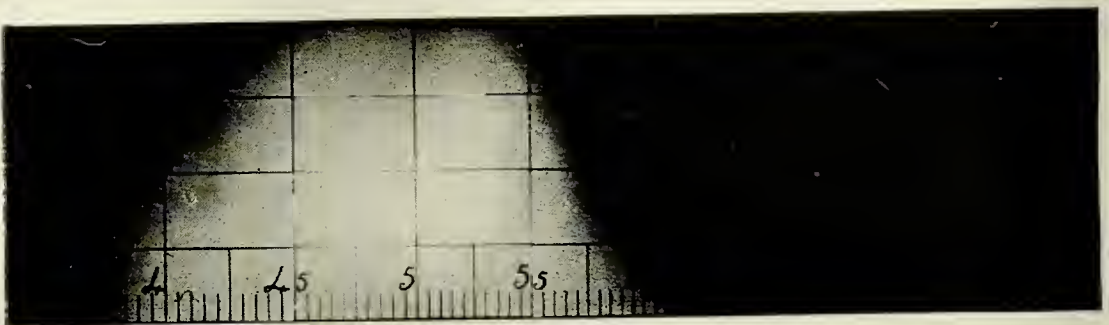


Fig. 167. Filter Blue Green 1/1,000.

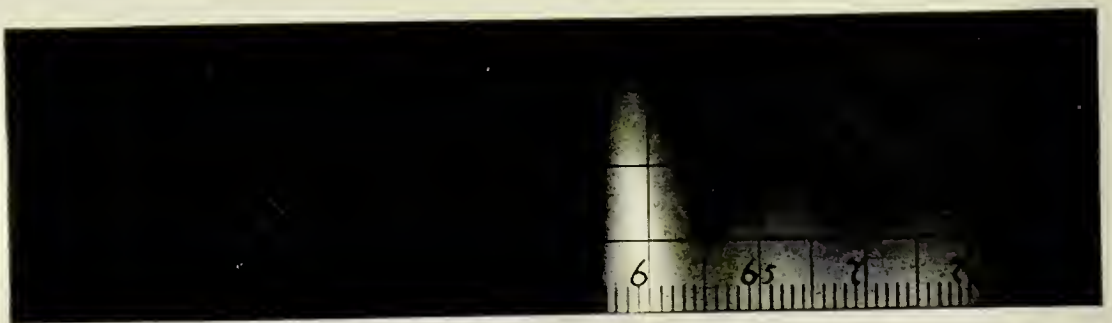


Fig. 168. Filter Blue Green 1/500 (Red end only).

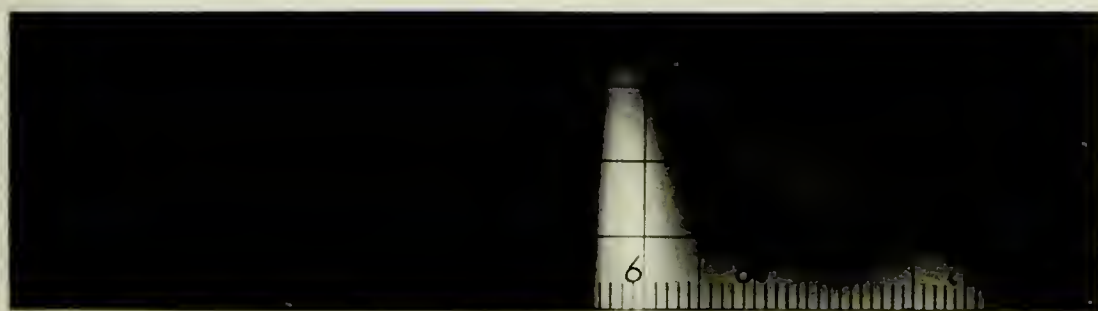


Fig. 169. Filter Blue Green 1/200 (Red end only).



Fig. 170. Filter Blue Green 1/100 (Red end only).

Filters.

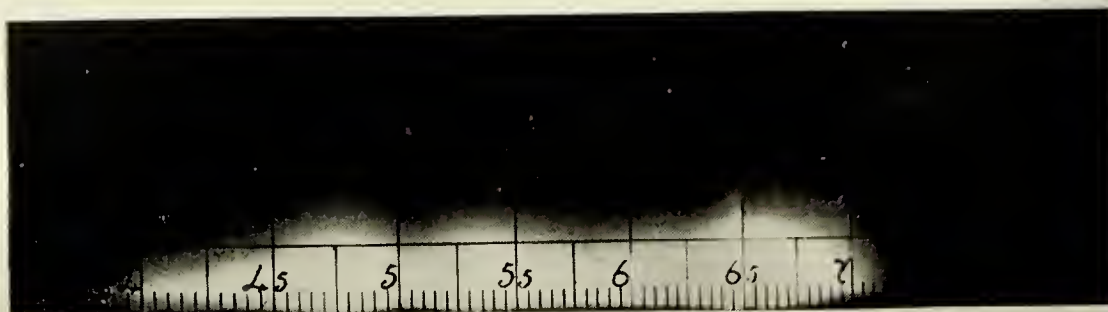


Fig. 1. β -Naphtholdisulphonic Acid.

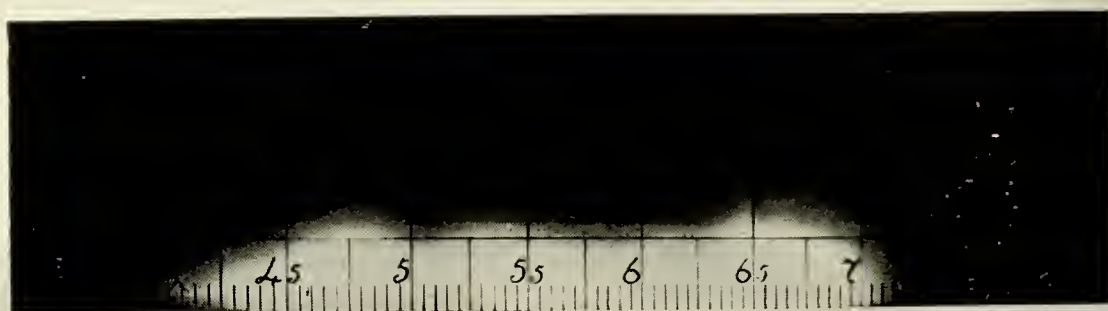


Fig. 2. *Æsculine*.

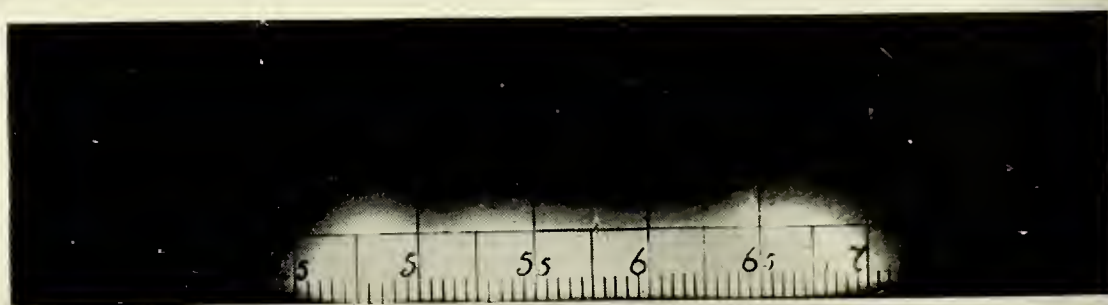


Fig. 3. Picric Acid "D."

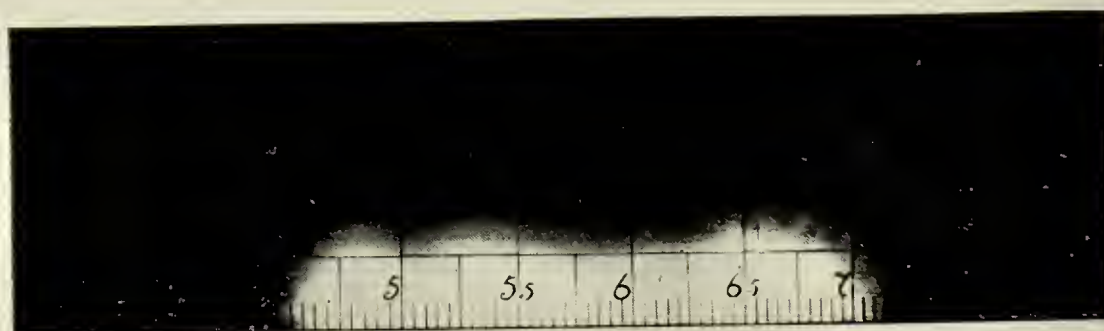


Fig. 4. Picric Acid "C."

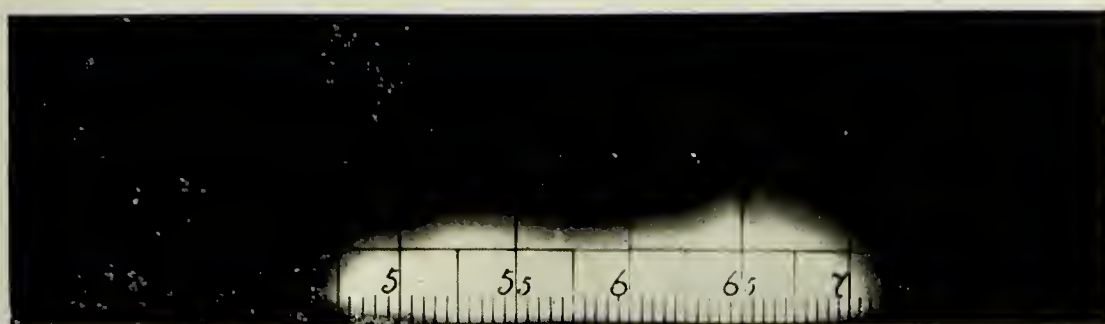


Fig. 5. Picric Acid "B."

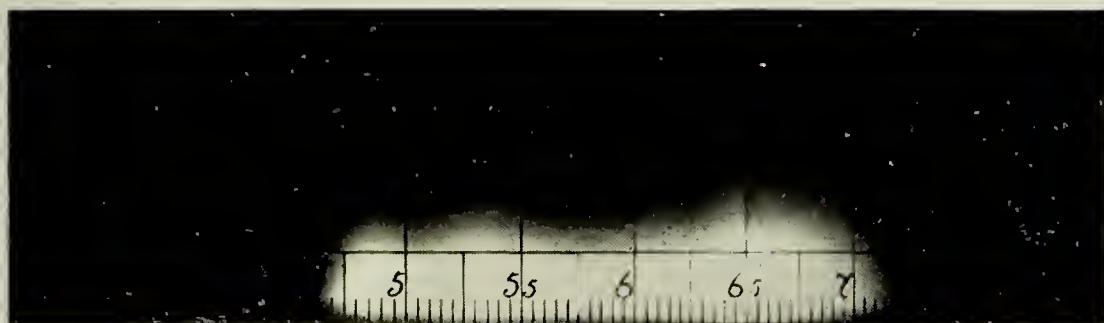


Fig. 6. Picric Acid "A."

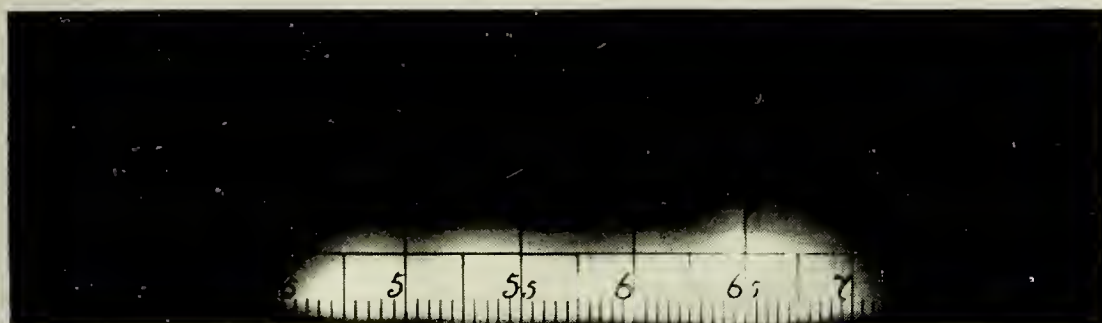


Fig. 7. K1.

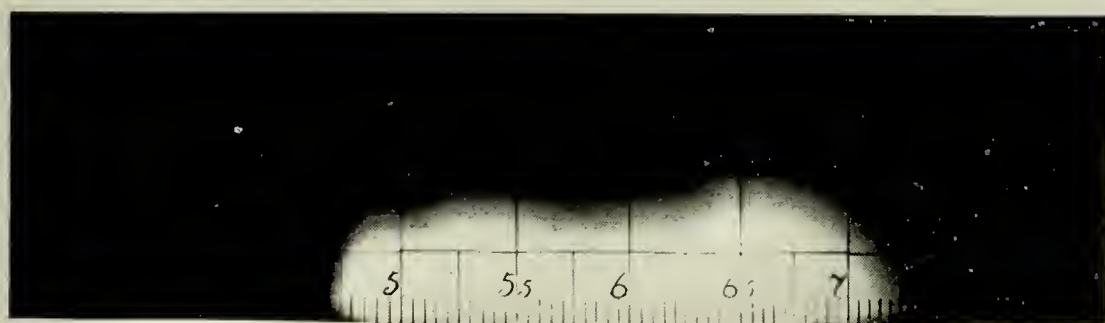


Fig. 8. K2.

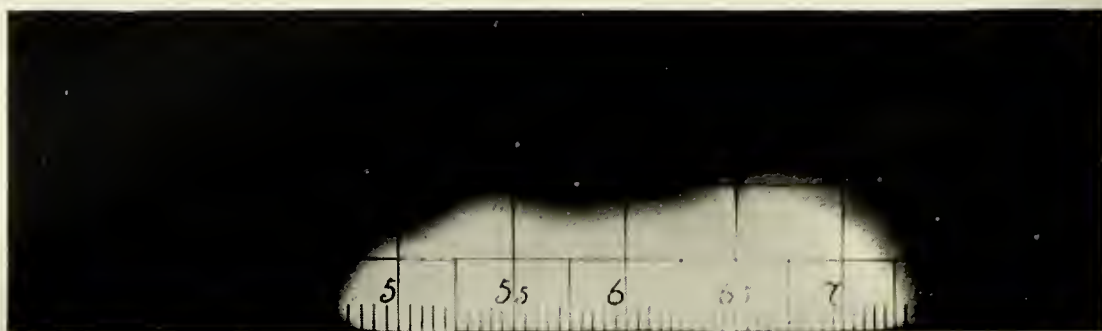


Fig. 9. K.3 M.

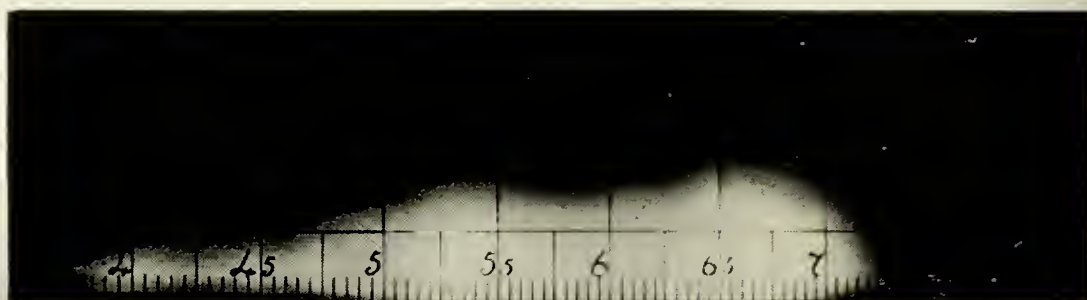


Fig. 10. Tartrazine 1.

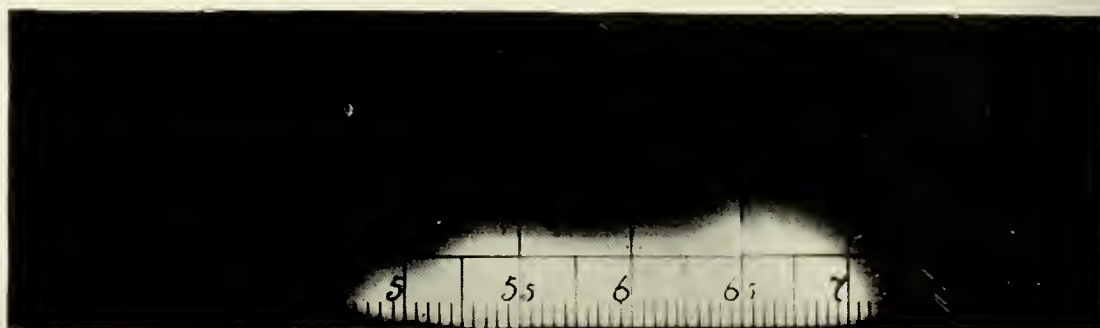


Fig. 11. Tartrazine 2

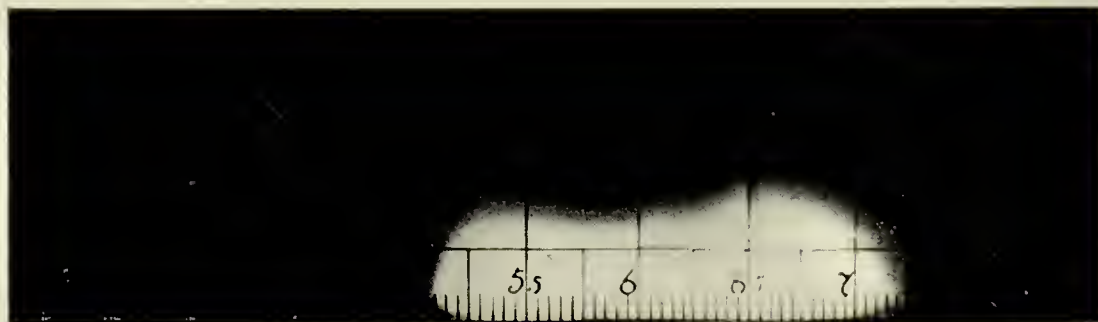


Fig. 12. Minus Blue. Standard Complementary.

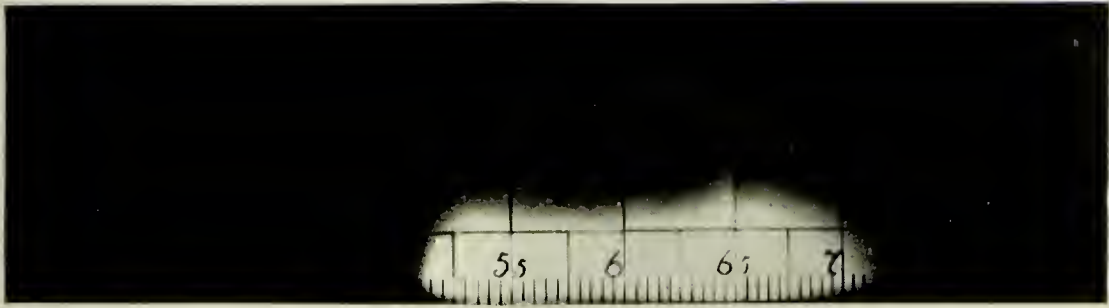


Fig. 13. G.A. 1.

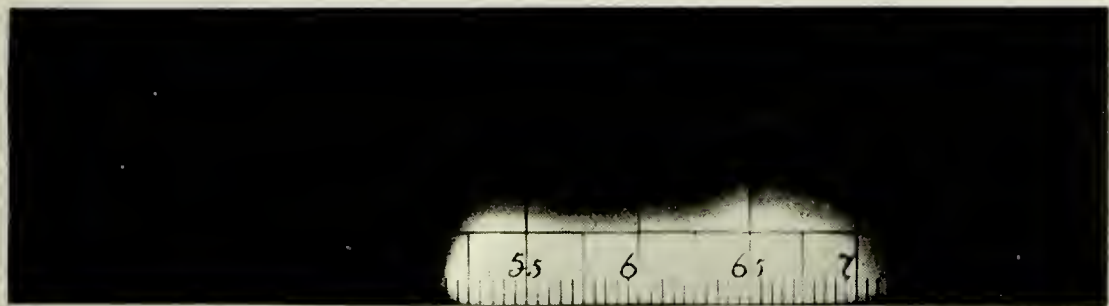


Fig. 14. G.A. 4.

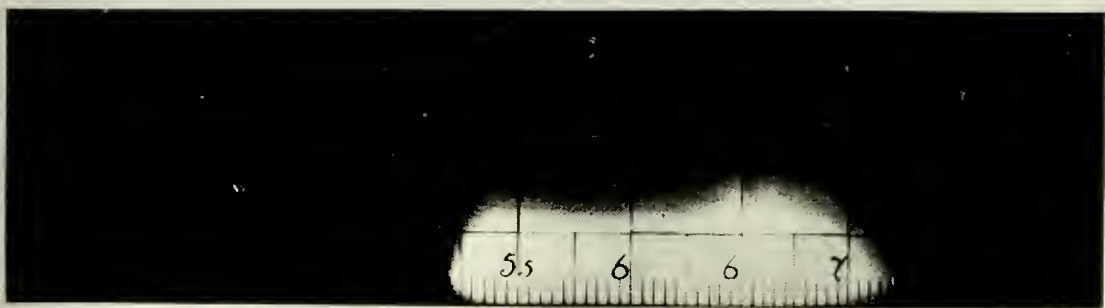


Fig. 15. G M.

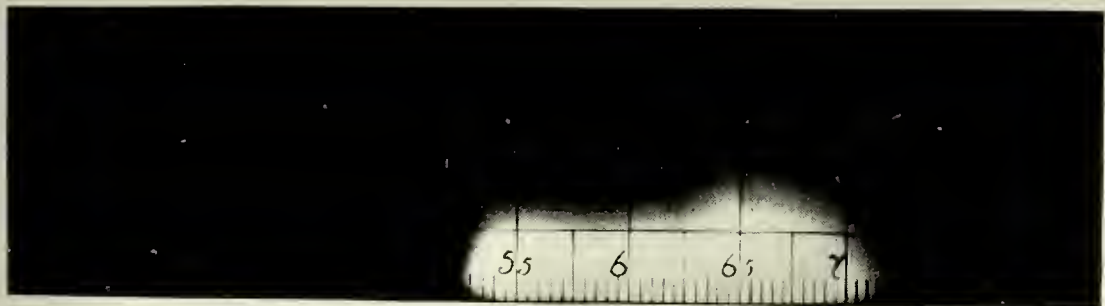


Fig. 16. Flavazine T.

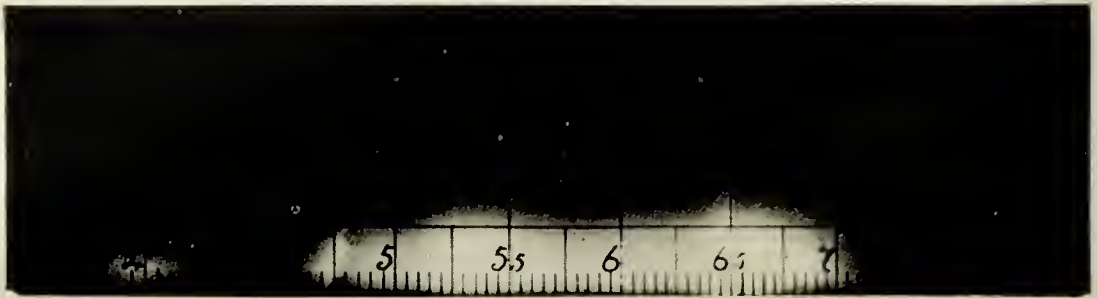


Fig. 17. *p*-nitrosodimethylaniline.



Fig. 18. Ultraviolet Filter.

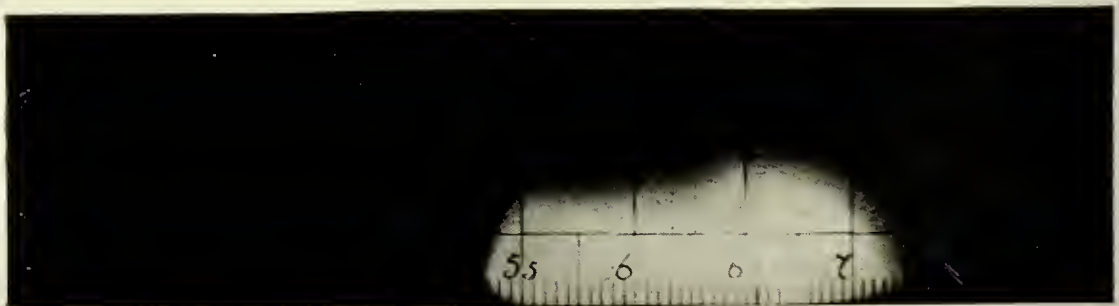


Fig. 19. Mandarinine Orange.

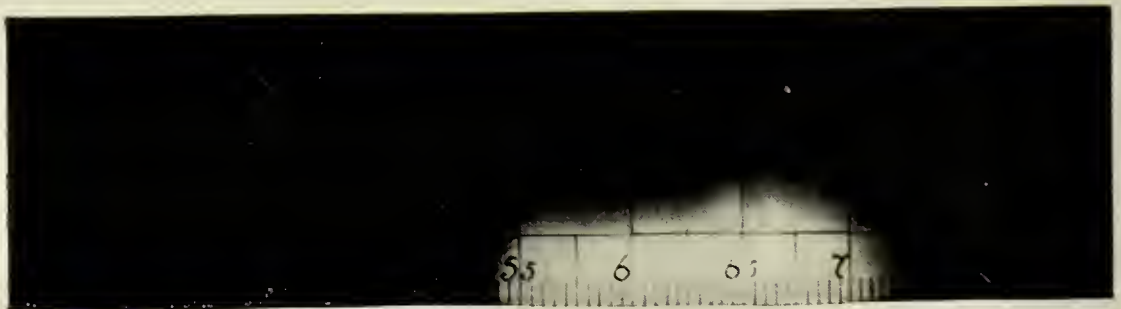


Fig. 20. Monobromofluoresceine (light).

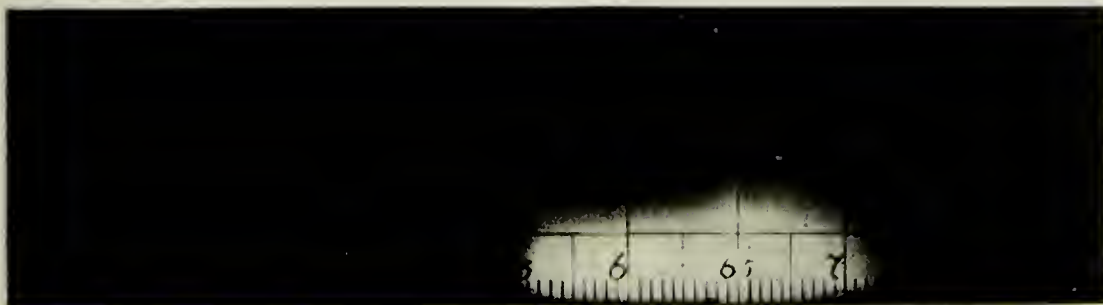


Fig. 21. Monobromofluoresceine (dark).

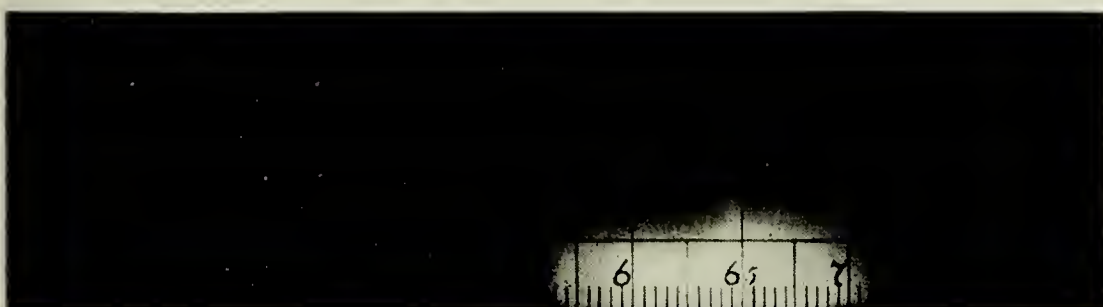


Fig. 22. E2 "M."

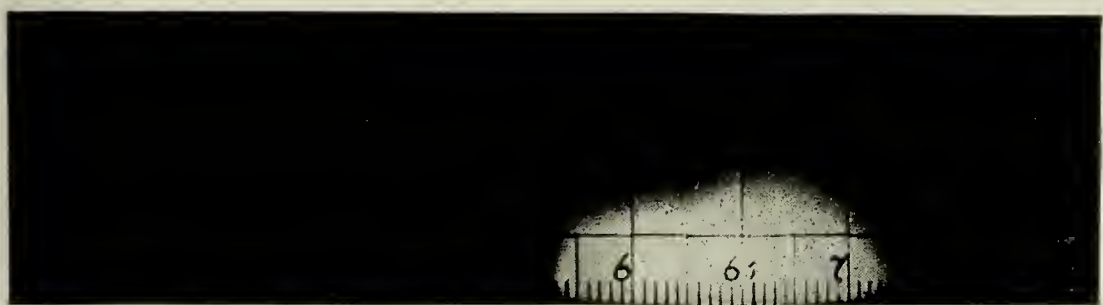


Fig. 23. E1.

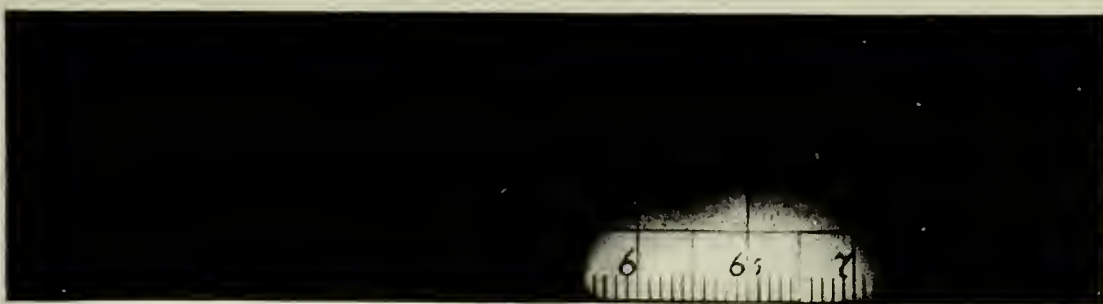


Fig. 24. E (red).

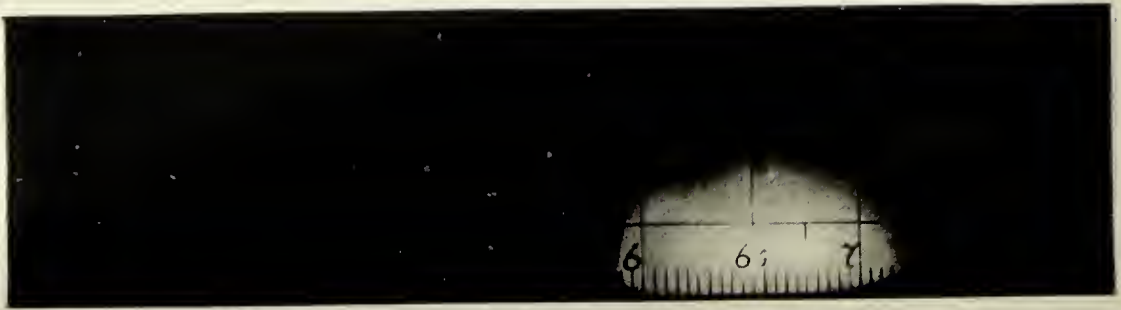


Fig. 25. A.M. Standard Tricolour.



Fig. 26. Stereo Red.



Fig. 27. F1.

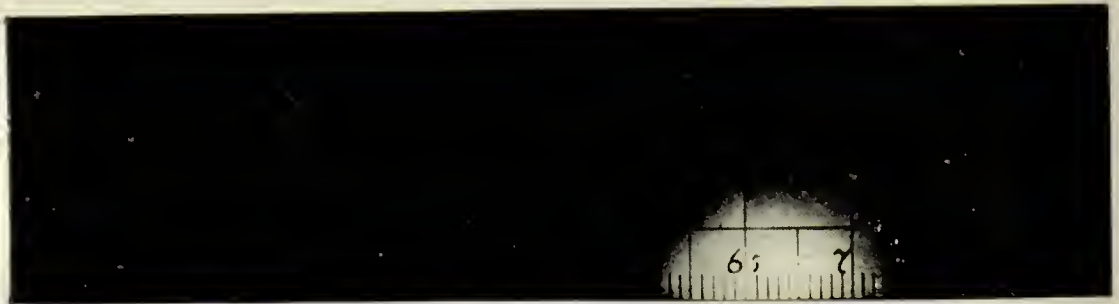


Fig. 28. F2.



Fig. 29. F3. M.

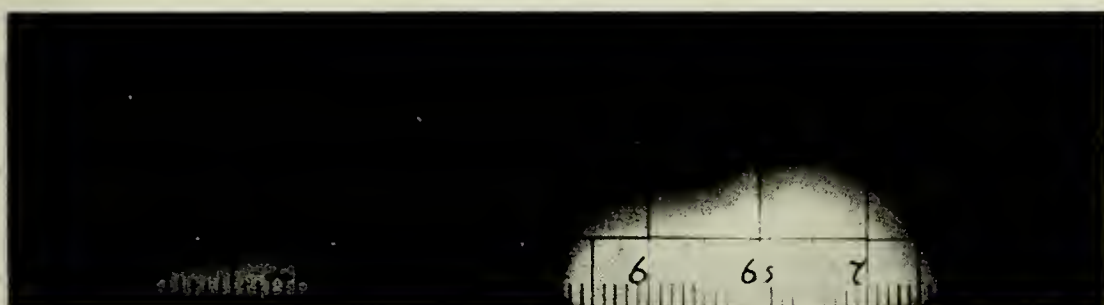


Fig. 30. Rose Bengal.



Fig. 31. Minus Green 1.



Fig. 32. Minus Green 3. Standard Complementary.

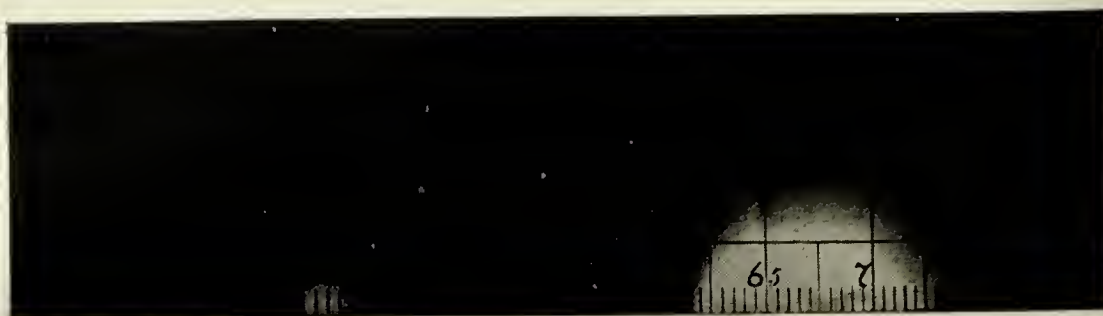


Fig. 33. Xylene Red.



Fig. 34. D (light).



Fig. 35. D. M.



Fig. 36. Methyl Violet B.B.R.

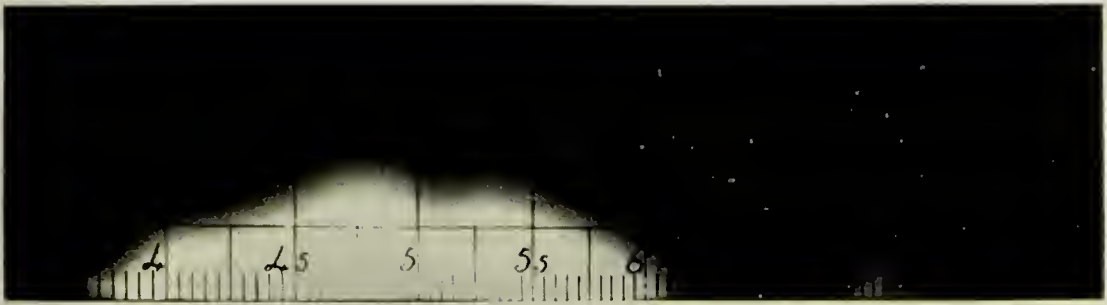
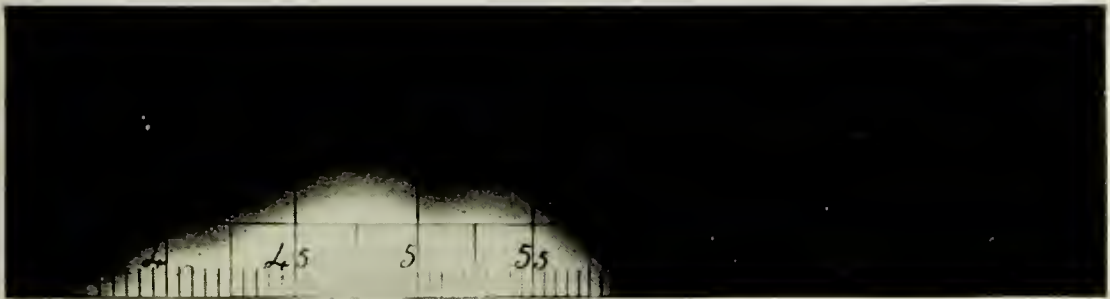
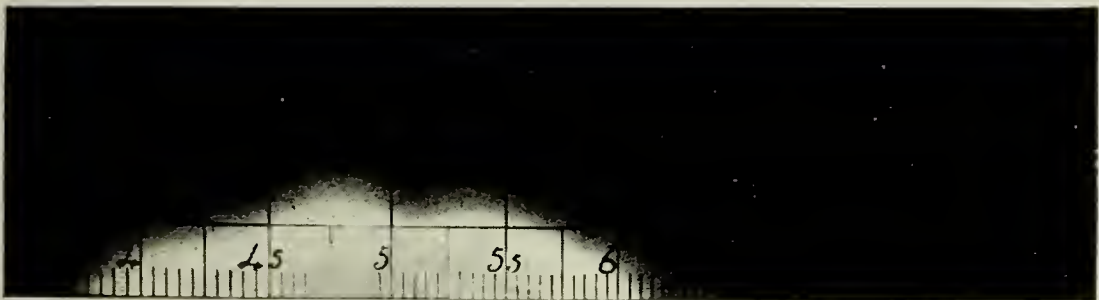
Fig. 37. β Blue.Fig. 38. β Blue (dark)

Fig. 39. Blue 203.

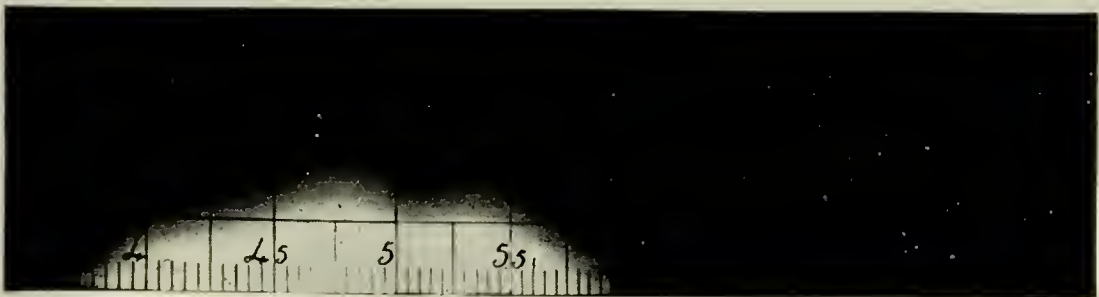


Fig. 40. Blue 316.



Fig. 41. Blue 363.

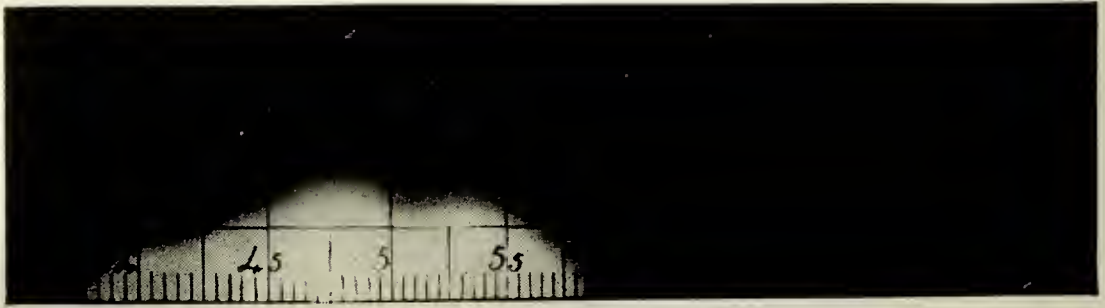


Fig. 42. Blue 445.



Fig. 43. Minus Red 2.

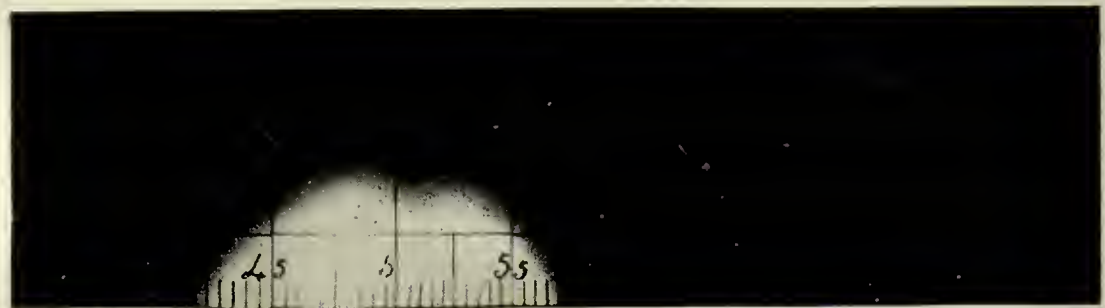


Fig. 44. Minus Red 4. Standard Complementary.



Fig. 45. H. M.

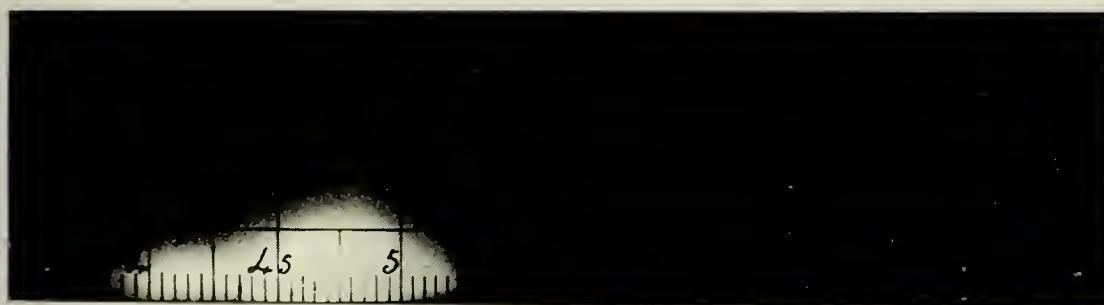
Fig. 46. η Blue.

Fig. 47 C (light).

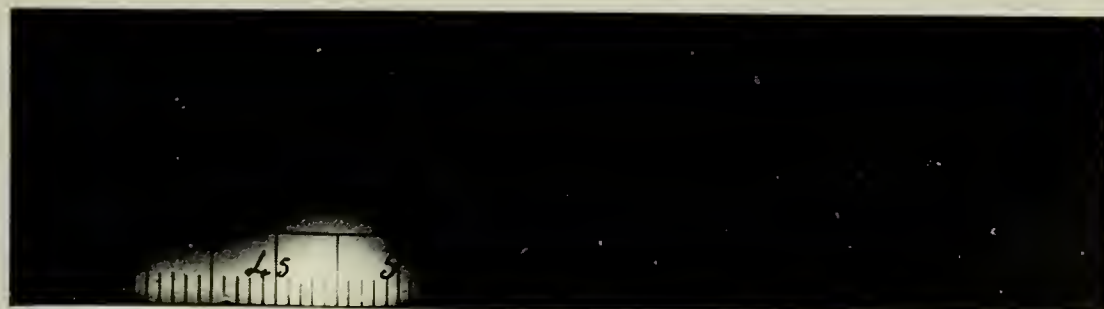


Fig. 48. Cl. M. Standard Tricolour.



Fig. 49. C2.

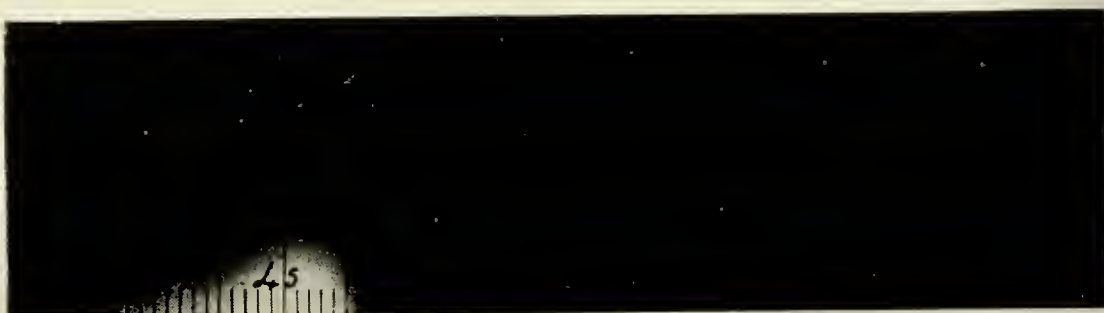


Fig. 50. L. Mercury Violet. Mercury Monochromat.

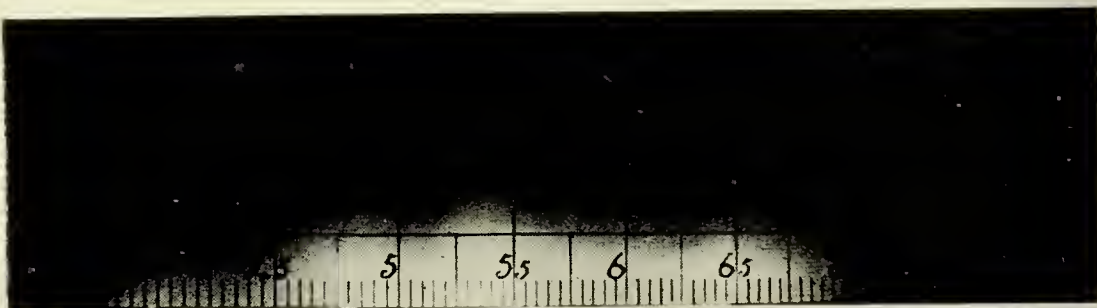


Fig. 51. Naphthol Green 1.

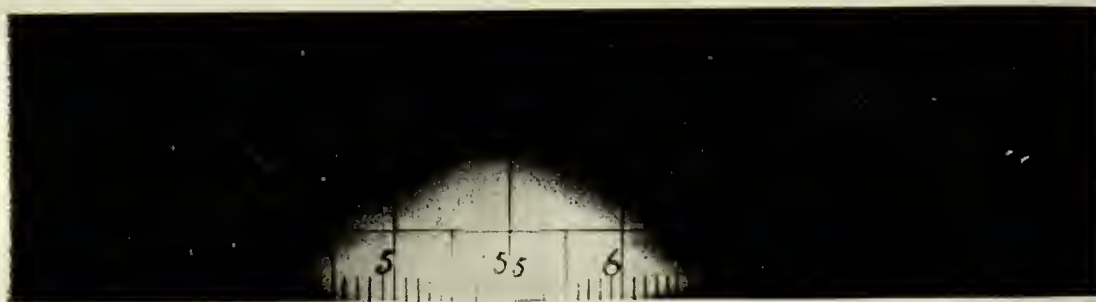


Fig. 52. Naphthol Green 2.

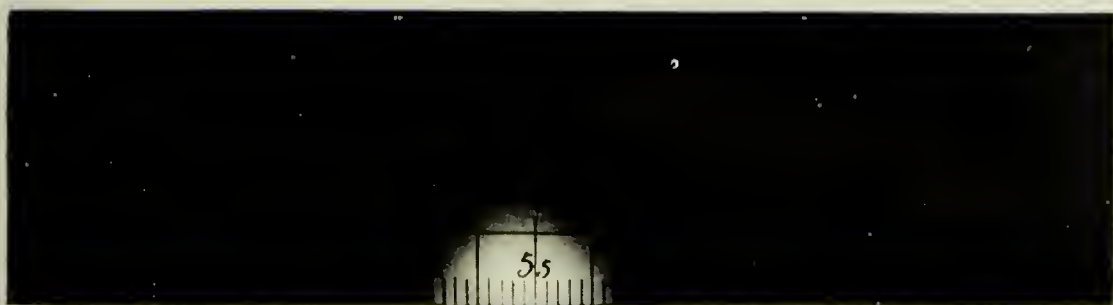


Fig. 53. Naphthol Green 3.



Fig. 54. Naphthol Green 4.

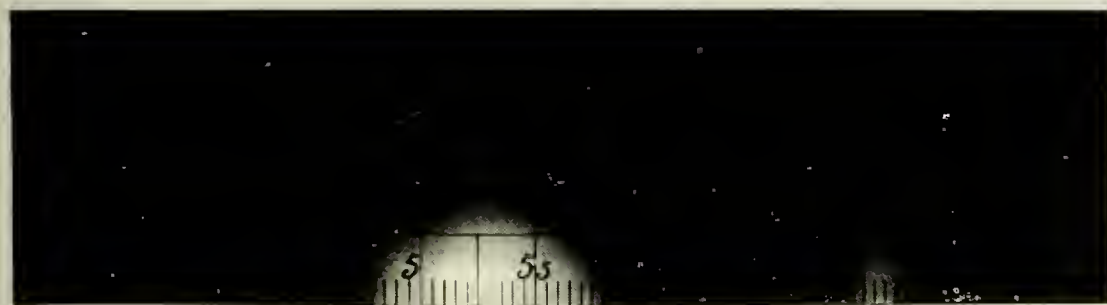


Fig. 55. Stereo Green.

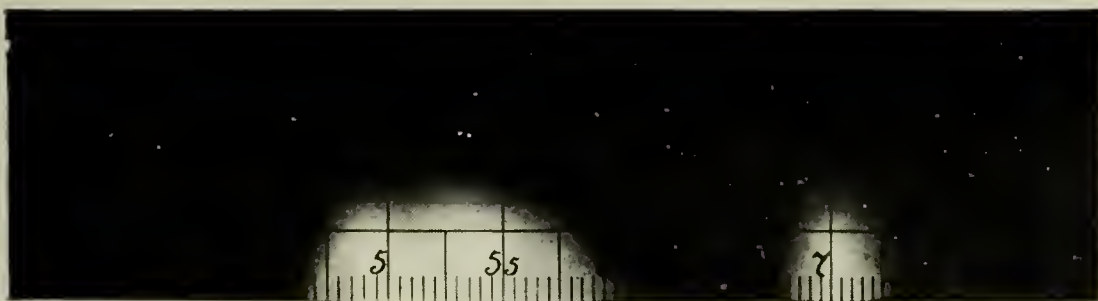


Fig. 56. B3.



Fig. 57. B2 (light).



Fig. 58. B2.

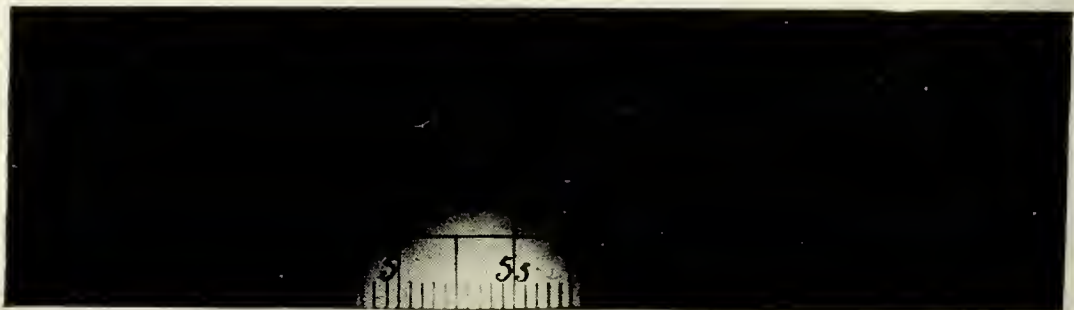


Fig. 59. B. M. Standard Tricolour Green.

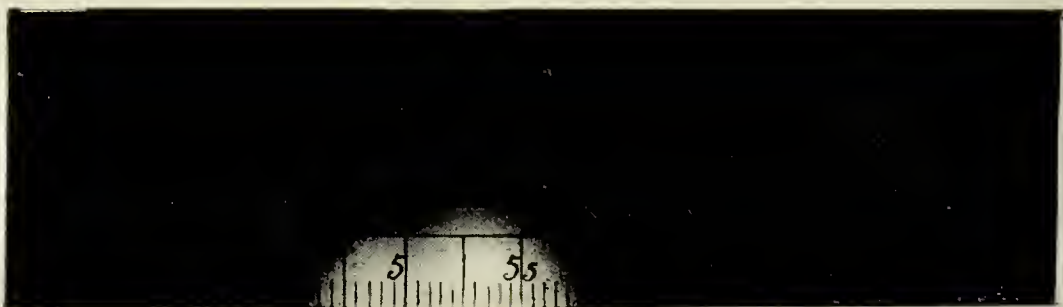


Fig. 60. P. δ Green.

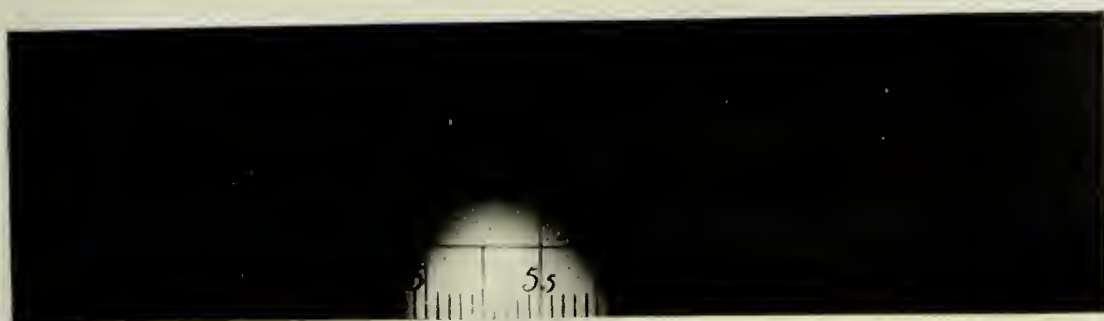


Fig. 61. N. Additive Green.



Fig. 62. Mercury Green. (Mercury Monochromat.)

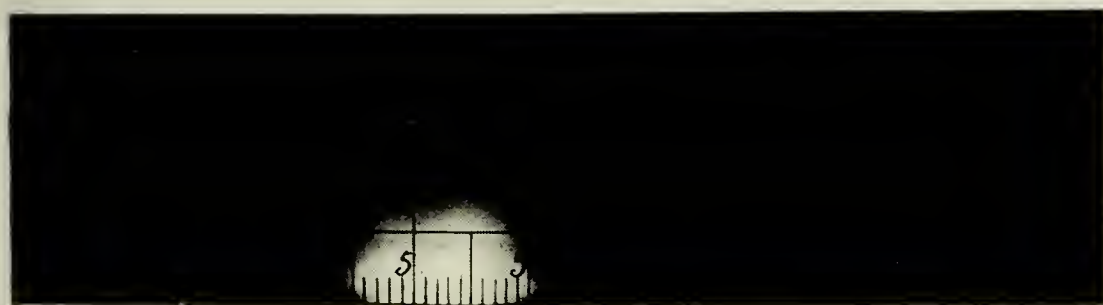


Fig. 63. ϵ Green.

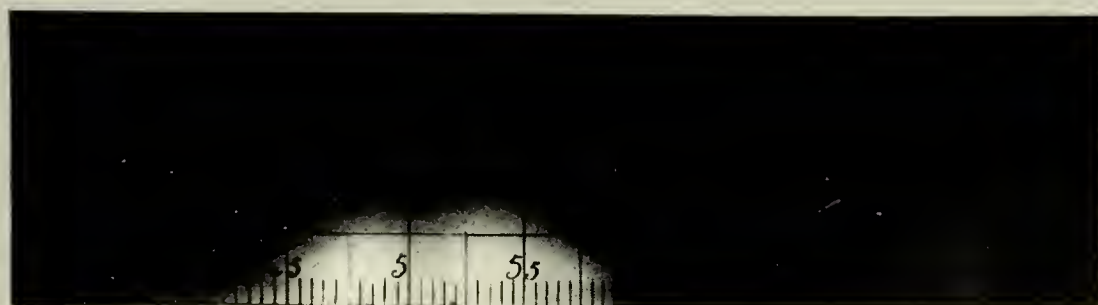


Fig. 64. Minus Red 3 (light).



Fig. 65. Minus Red 3.

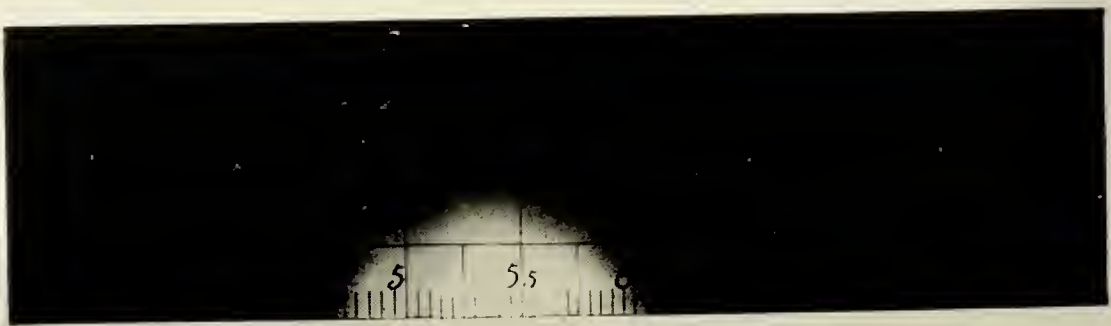
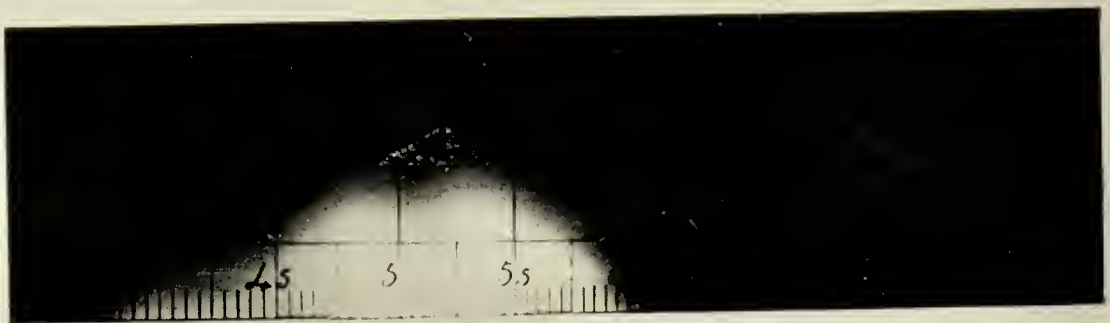


Fig. 66. Rapid Filter Green.

Fig. 67. γ Green 2.Fig. 68. γ Green 3.

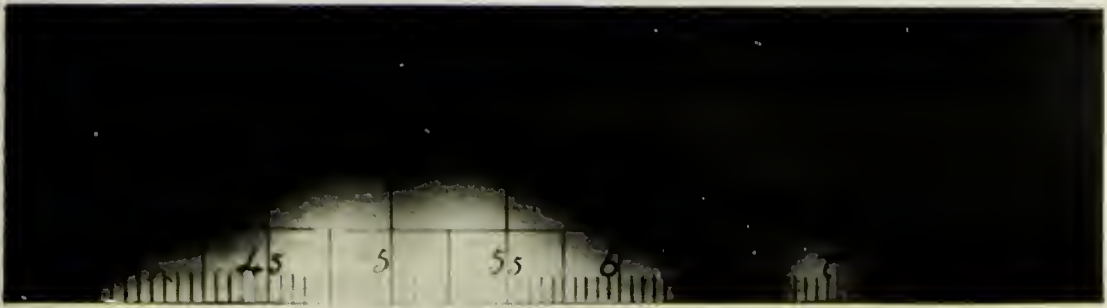


Fig. 69. γ Green 4.



Fig. 70. α (Monochromat).



Fig. 71. β (Monochromat).

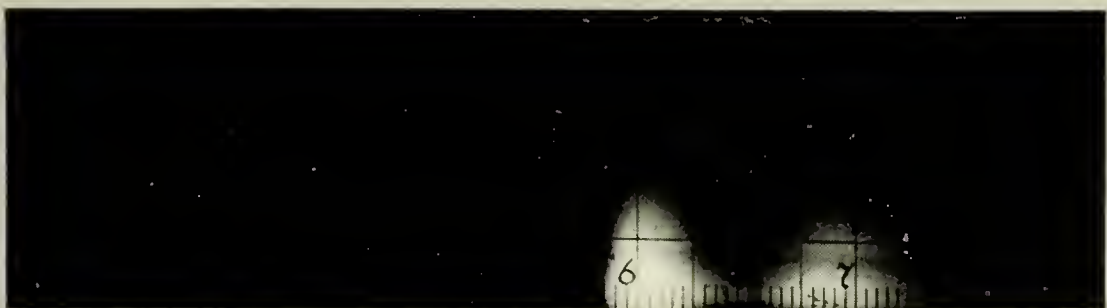


Fig. 72. γ (Monochromat).



Fig. 73. δ (Monochromat).

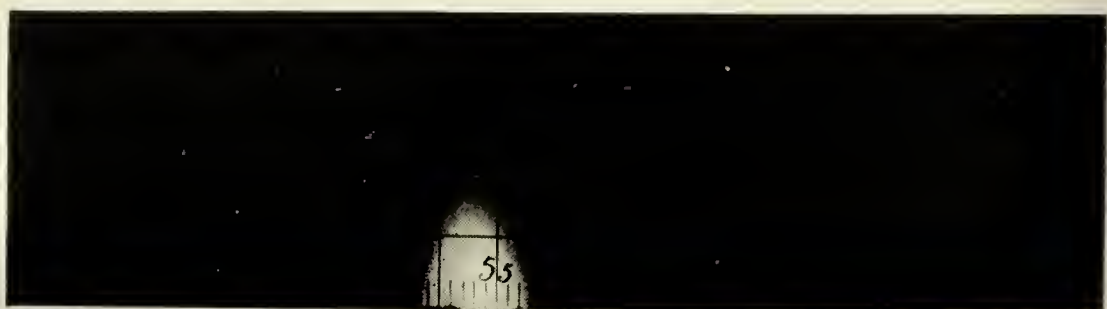


Fig. 74. ϵ (Monochromat).

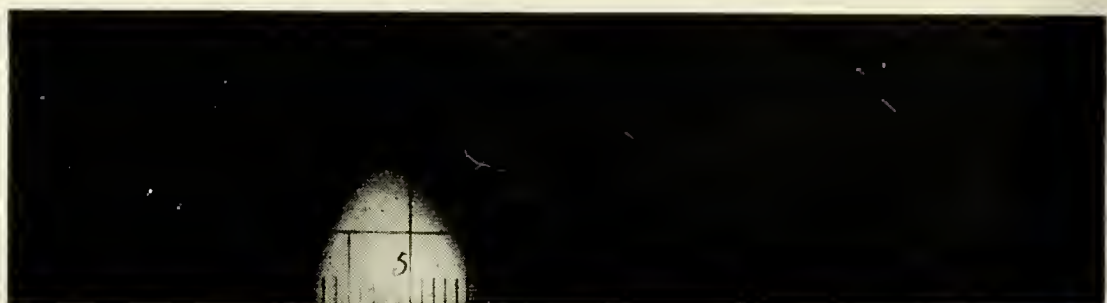


Fig. 75. η (Monochromat).



Fig. 76. θ (Monochromat).

